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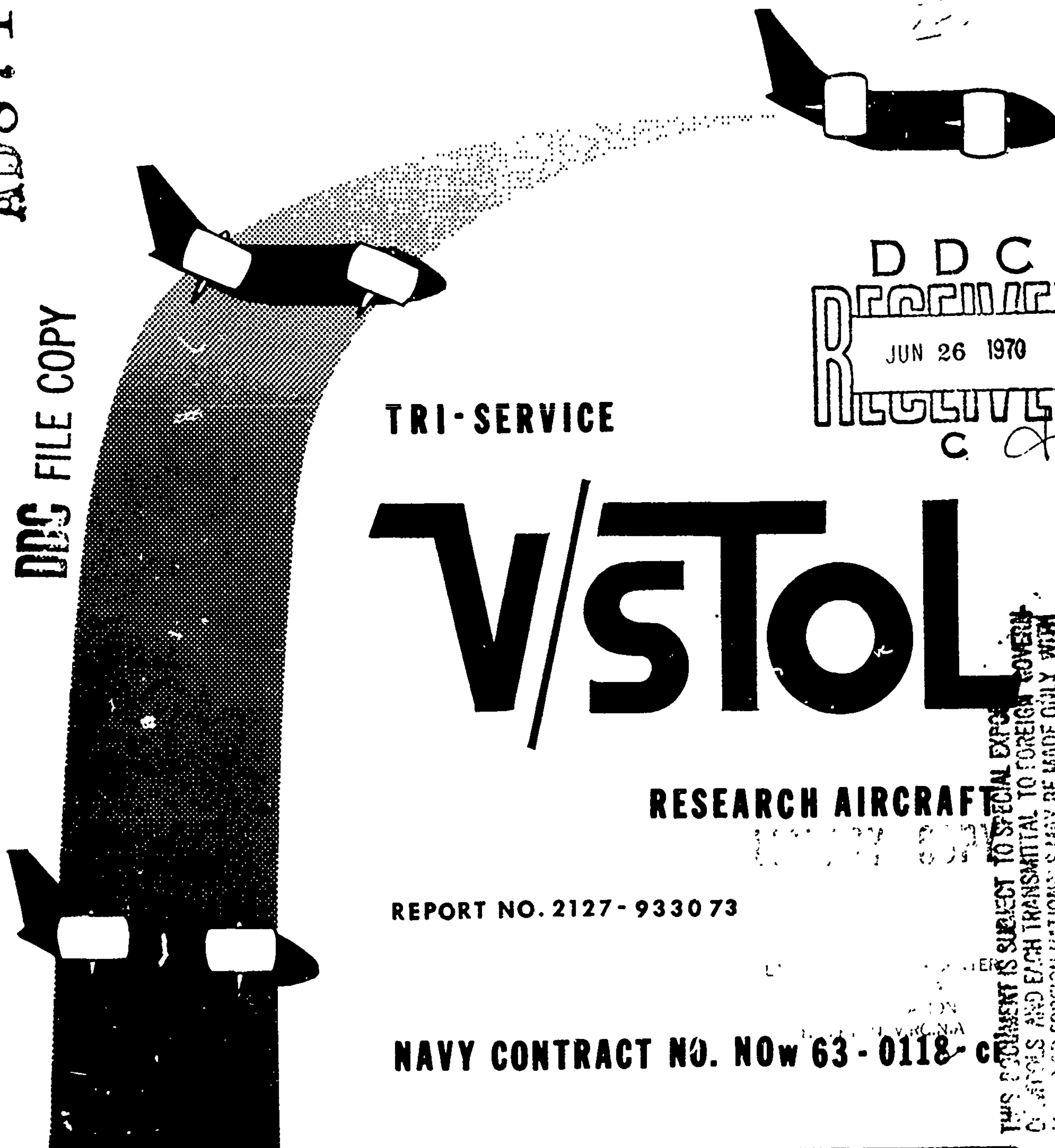
N-126237

X-22A PROGRESS REPORT NO. 73

FINAL (April-December 1969)
(Including Flight Test Summary)



TRI-SERVICE

V/STOL

RESEARCH AIRCRAFT

REPORT NO. 2127-933073

NAVY CONTRACT NO. NOw 63-0118-c

Bell Aerospace Company

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IN BLACK AND WHITE

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BELL AEROSPACE COMPANY
Buffalo, New York 14240

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20 April 1970
Letter No. 1473

TO: Commander, Naval Air Systems Command
Department of the Navy
Main Navy Building
Washington, D. C. 20360

ATTENTION: AIR-5104D

SUBJECT: Contract NOw 63-0118-ci
X-22A Research Aircraft
Final Progress Report No. 73
April - December 1969

REFERENCE: (a) Navy Contract NOw 63-0118-ci
Section (F) -5

(b) Navy Contract NOw 63-0118-ci
Mod. 59, dated 8 October 1969

ENCLOSURE: (A) Five copies of Final Progress Report
No. 73 (April - December 1969)
BAC No. 2127-933073

VIA: Mr. J. Patterson
DCRB - DRGFC
1021 Main Street
Buffalo, New York 14203

Enclosure (A), the 73rd X-22A Progress Report, is submitted in accordance with References (a and b) and covers the period 1 April through 31 December 1969.

The report is considered as final as the aircraft development program was completed and delivered in the 2nd quarter of 1969. The remaining tasks of temporary storage and aircraft No. 1 disassembly and all other contract deliverable items were completed prior to 31 December 1969.

As this is the 73rd and final report, a Summary of X-22A Development Flight Test has been incorporated to reflect the full design and test story of this successful V/STOL research aircraft.

BELL AEROSPACE COMPANY

H. C. Marquardt
Project Director - X-22A

rar
Enc.
cc: See attached sheets

BELL AEROSPACE COMPANY
Buffalo, New York 14240

647:70:0420-1:HCM
20 April 1970
Letter No. 1473
Page 2

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for X-22A (Final) Progress Report

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X-22A TRI-SERVICE V/STOL AIRCRAFT

FINAL PROGRESS REPORT (INCLUDING FLIGHT TEST SUMMARY)

Report No. 2127-933073

April-December 1969

This is the seventy-third Progress Report as required in Section F (5) of the contract. Late in 1968 this reporting provision was changed by NAVAIR Contract direction. This seventy-third report outlines progress for the period 1 April 1969 through 31 December 1969. For a brief introduction of the X-22A Program refer to reports prior to May 1964.

Limited number of copies containing color other than black and white are available until stock is exhausted. Reproductions will be made in black and white only.

H.C. Marquardt
Project Director
X-22A Program

CONTENTS

ILLUSTRATIONS

I. SUMMARY

This report covers the nine-month period from 1 April 1969 through essential program completion 31 December 1969. Activities were highlighted with two major milestones in the second quarter of 1969, the final Military Pilot Evaluation (MPE) and the aircraft acceptance by NAVAIR. The remainder of the period represented effort completing final reports, the "live" storage of the X-22A pending new contract flying, and the disassembly of Aircraft No. 1 for salvageable spare parts. As these tasks were for all practical purposes completed, this report is being issued as a final progress report at the calendar close of 1969.

During April, the Phase II final MPE (Figure 1) took place. Following ground school training and cockpit checks, eleven flights totaling twelve hours were flown on six consecutive days with five military pilots flying the aircraft. The MPE critique of 11 April produced no major discrepancies. Later in the month, a post MPE meeting was held at NAVAIR to discuss the MPE preliminary conclusions.

Following the close of the MPE, the aircraft was removed from flight status to ready it for the planned 2 May delivery. At the post MPE meeting and through April, the delivery and acceptance status of the vehicle was discussed. The Navy requested an acceptance date shift from the second to the sixteenth of May. The Bell hangar crew was reduced to one shift on the aircraft to comply with this stretch out. Plans leading to aircraft delivery ultimately formalized a date of 19 May as requested by NAVAIR for a group of Navy and DCASO representatives to be at Bell. Contractual delivery and a formal acceptance ceremony were completed that day (Figure 2).

Following Navy acceptance the aircraft was placed in temporary "live" storage pending new contract authorization. A seven-week strike at Bell ensued from 9 June through 25 July during which time the aircraft status was monitored in the hangar by supervisory personnel.

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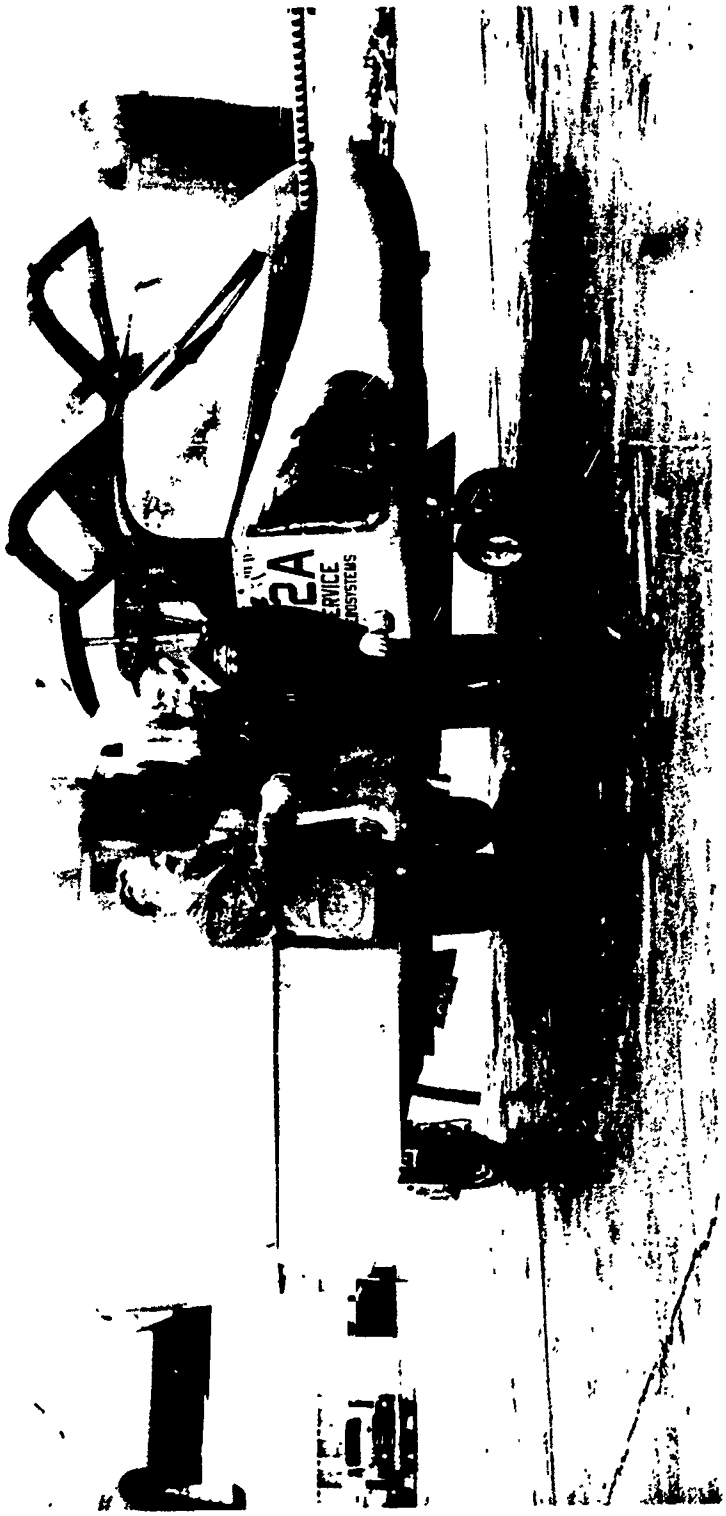

Figure 1. Final MPE Completion

(Major W. Scheuren being congratulated by H. C. Marquardt upon completion ahead of schedule)

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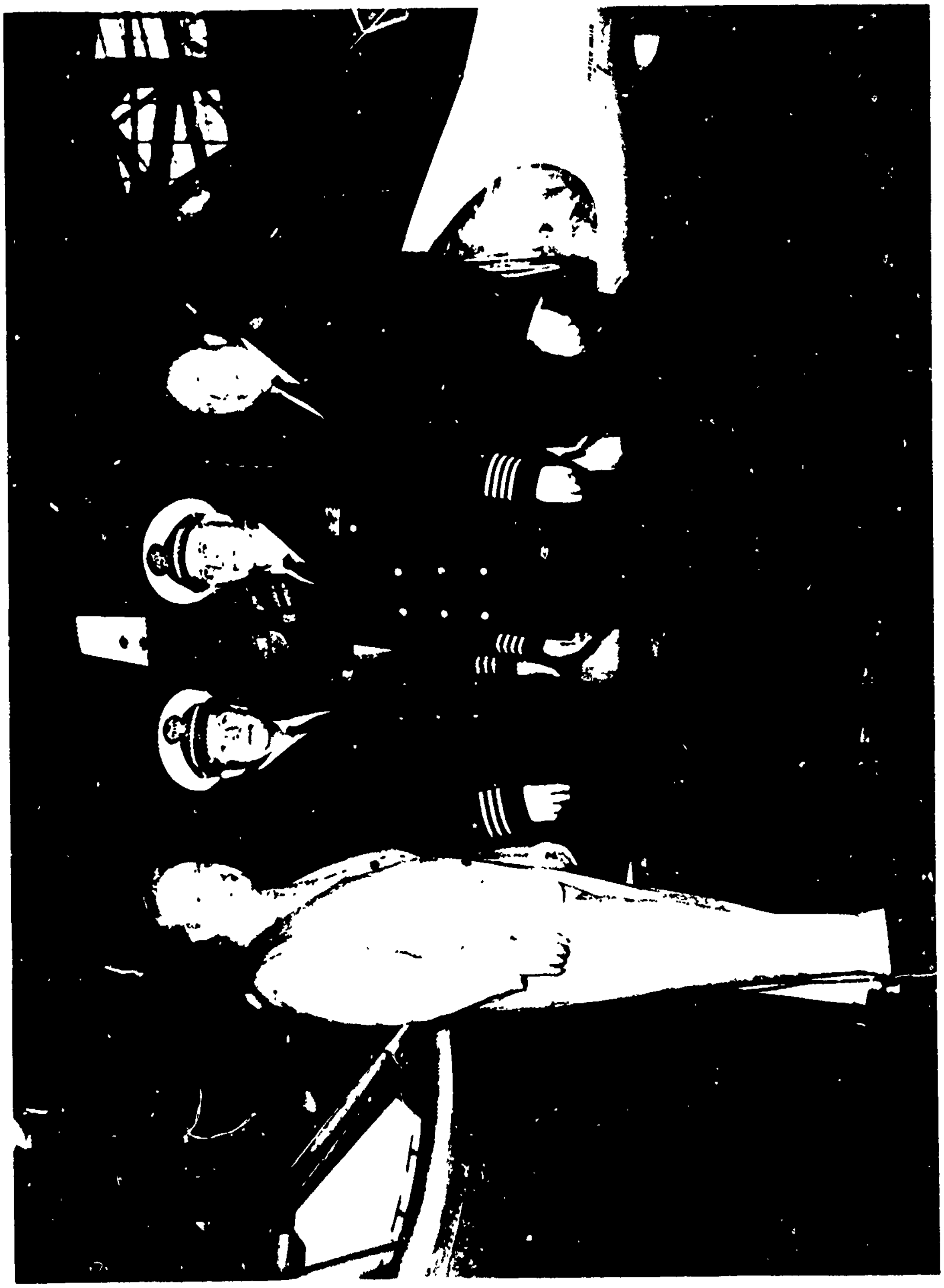


Figure 2. Aircraft Acceptance 19 May 1969

(H. C. Marquardt, Cdr F. Highsmith, Capt R. F. Schall & W. G. Gisel)

During the March through May period, Bell and NAVAIR continued discussing the proposed three year follow-on program. As this program was not materializing, an interim pilot training program was planned as a new contract effort to follow aircraft delivery and precede the follow on. The interim program was subsequently authorized to start 18 August as a separate contract for ground school and flight training for three pilots and evaluation flying for two NASA pilots. The X-22A was supplied to this new contract as GFE and reporting for this program was made separate from this report. Through this interim program Bell pursued the initiation of the follow-on effort and it now appears that work may begin on the follow-on program in the second quarter of 1970.

Differences of contractual position arising from the removal of Aircraft No. 1 from flight status and the Navy decision to withdraw it from the program and not to repair or replace it, led to the Armed Services Board of Contractors Appeal (ASBCA) decision and stipulation of 6 June 1968. Since that time Bell continued active efforts to conclude the matter. During the period of June and July 1969 concerted efforts with NAVAIR Contracts formulated a settlement. This was contractually finalized with Contract Modification No. 59, dated 9 October 1969.

In May 1969, the Navy directed disassembly of Aircraft No. 1 to be accomplished under the basic contract. This effort has culminated in an inventory of parts for possible later reconditioning as spares.

On 12-13 August NAVAIR personnel were at Bell to discuss final contract reporting and flight test data requirements. Contractual and program report efforts during the past months have now been completed. This report concludes that phase. The Contractors efforts are currently concentrated on the disposal and disposition of the last details of residual inventories, tooling, etc. Figure 3 shows the program schedule to essential completion during the calendar year 1969.

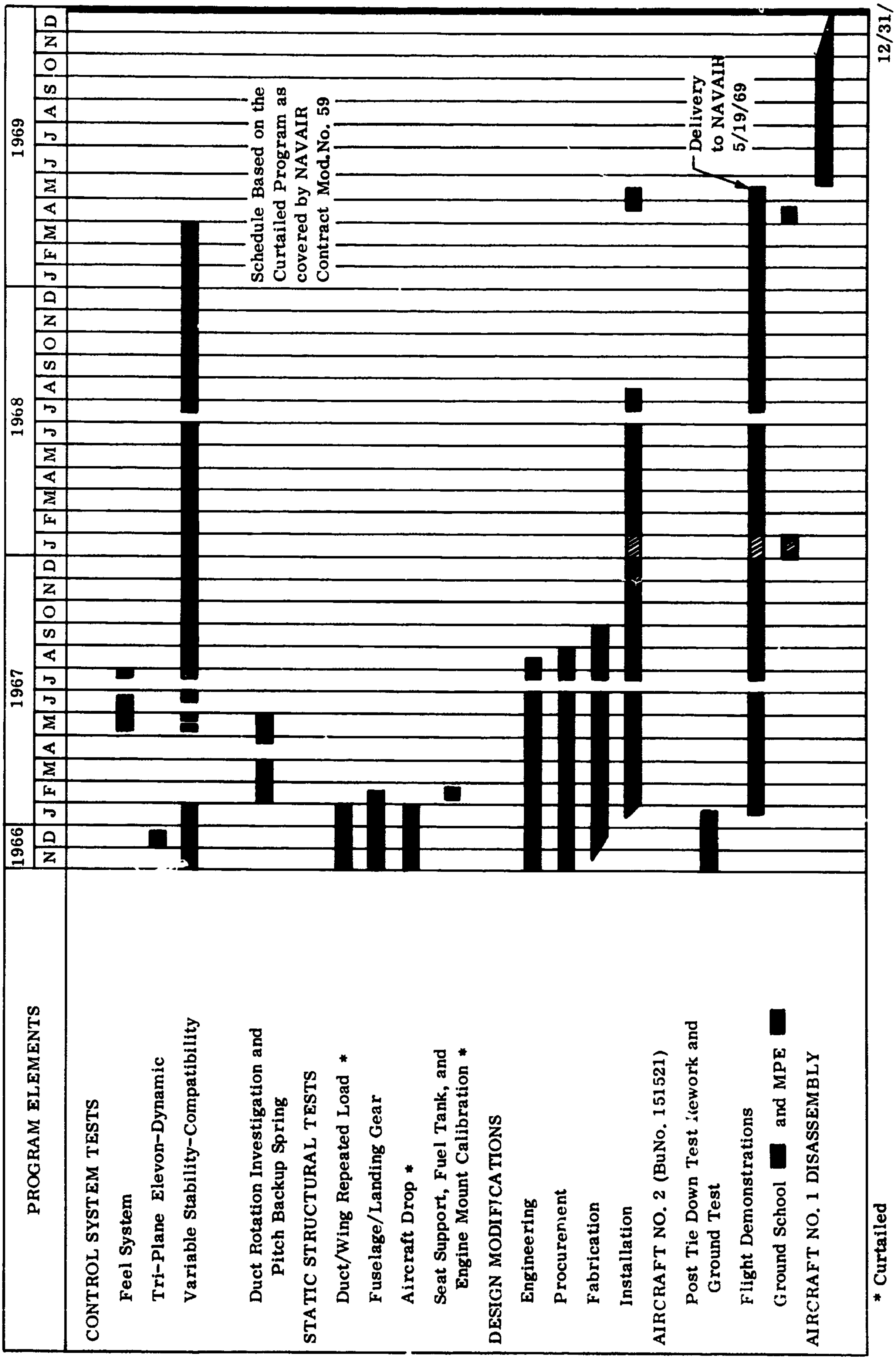


Figure 3. X-22A One Aircraft Program Schedule

II. SUMMARY OF X-22A DEVELOPMENT FLIGHT TEST

X-22A TRI-SERVICE DUAL TANDEM DUCTED PROPELLER V/STOL RESEARCH AIRCRAFT

A. OUTSTANDING FEATURES OF THE X-22A AIRCRAFT

(1) High thrust to weight ratio (T/W = 1.35 standard day) allows an engine-out VTOL capability on a hot day.

(2) High level of VTOL control powers allows handling qualities research through the use of a Variable Stability System (VSS).

(3) Sophisticated Variable Stability System (VSS) allows large range of variable parameters required for handling qualities research.

(4) Hover attitude control is obtained by power transfer between duct pairs with no height coupling at large control inputs.

(5) Stability Augmentation System (SAS) is independent of VSS.

(6) Artificial Feel System (AFS) is compatible with all modes of flight.

(7) The X-22A has the capability to evaluate both collective pitch and power (throttle) thrust control systems in hover and transition.

(8) The aircraft is designed and manufactured to MIL Specs, and flight demonstrations correspond to MIL Spec requirements.

(9) Large transition envelope provides wide latitudes of handling in transition.

(10) High rates of descent capability at very slow speeds makes it possible to evaluate high approach angles independent of fuselage attitude.

B. GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

DIMENSIONS

Length	39.57 ft	
Height	20.69 ft	
Tread	8.0 ft	
Wing	Front	Aft
Area	139 sq ft	286 sq ft
Span	22.97 ft	39.24 ft
Aspect Ratio	3.86	5.38

ENGINE RATINGS

SHP	SLS	Thrust	rpm	Min.
1250	Mil.	154	19,500	30
1060	Nor.	132	19,500	Cont.

POWER PLANT

No. & Model	(4) YT58-GE-8D
Mfr.	General Electric Co.
Type	Free Power Turbine
Reduction Gear Ratio	0.133
Prop Mfr.	Hamilton Standard
Prop. Dia.	84 in.
No. of Blades	3
Tail Pipe	Fixed Area

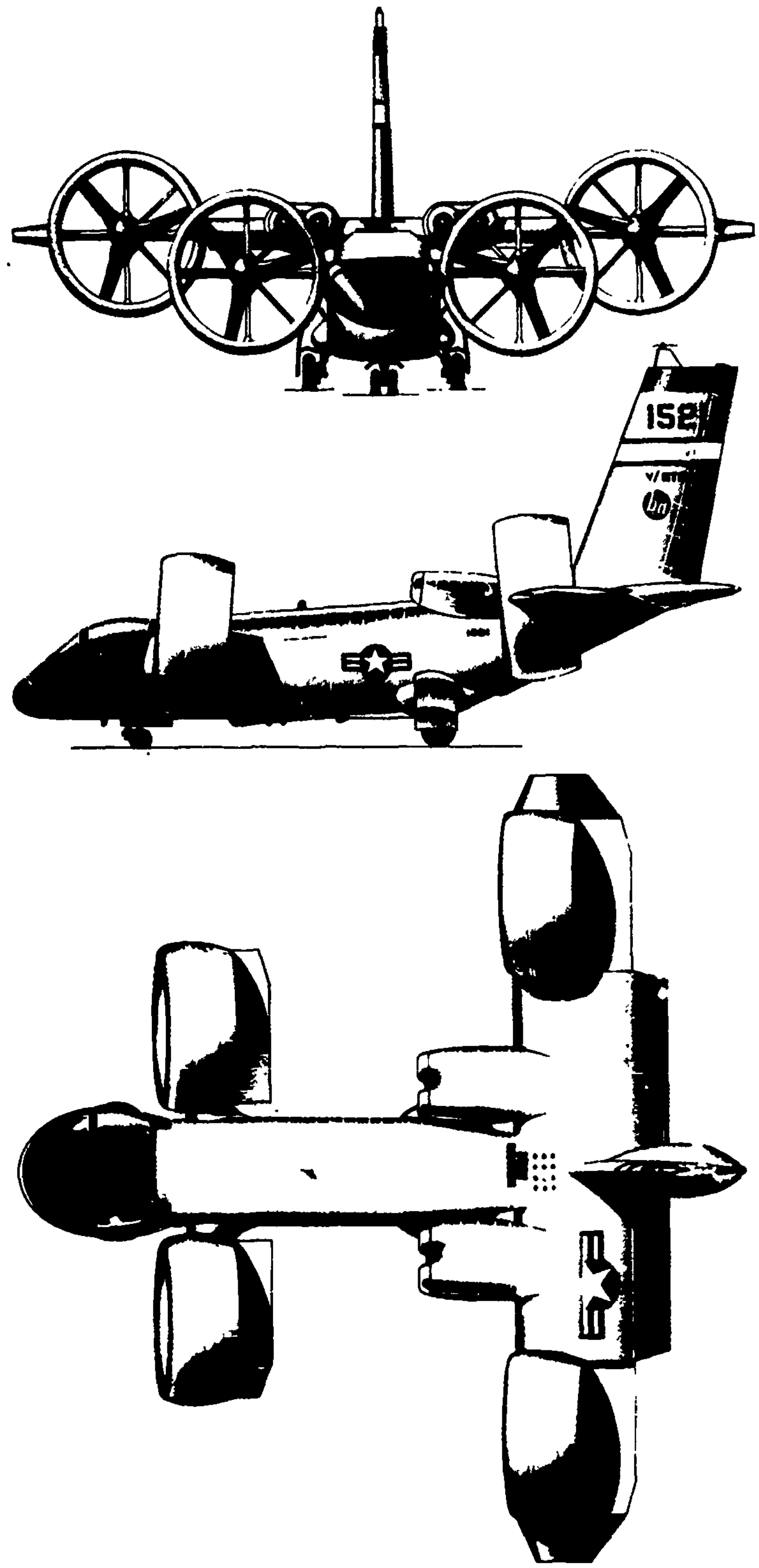
WEIGHTS

Loading	lb
Empty	11,622
Gross	15,287
Max Takeoff	18,420
Max Landing	15,287

FUEL

No. Tanks	Gal	Location
1	465	Fuselage

Fuel Grade JP-4 or JP-5



Control System
- C1 Height-control stick
- C2 Control column
- C3 Duct rotation button, force trim, variable-stability system engage/disengage
- C4 Throttles
- C5 Propeller r.p.m.
- C6 Undercarriage selector
- C7 Pedal adjustment
- C8 Variable-ratio bell-crank control mixing system
- C9 Control runs
- C10 Control runs to propeller and elevon P.C.U.s
- C11 Elevon power control unit
- C12 Elevon
- C13 Elevon hinge
- C14 7ft diameter Hamilton Standard propeller
- C15 Steel spline
- C16 Glass-fibre envelope
- C17 Duct-rotation hydraulic-drive units (4 sets)
- C18 Duct rotation interconnecting shaft
- C19 Duct rotation shaft brake
- C20 Beta (propeller pitch) control
- C21 Duct support tube
- C22 Duct support tube bearing
- C23 Duct rotation harmonic-drive wave generator
- C24 Harmonic-drive flexible spline
- C25 Variable-stability system electronics

Powerplant
- P1 General Electric YT58-GE-8D engines
- P2 Oil tank
- P3 Oil tank filler
- P4 Engine support beam (titanium)
- P5 Engine mounting cross-beam
- P6 Two-piece cowlings
- P7 Firewall
- P8 Engine output shaft (19,500 r.p.m.)

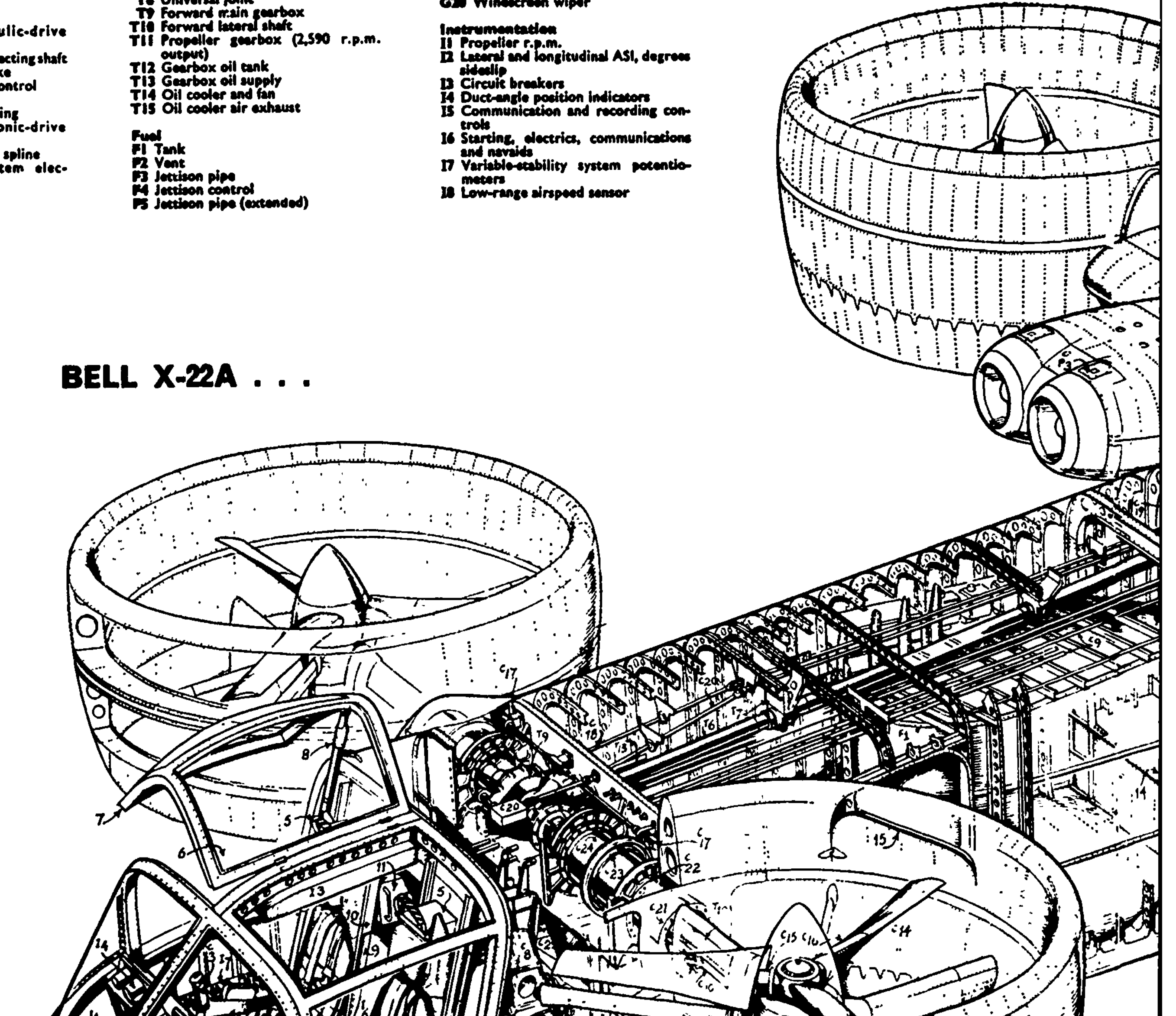
Transmission System
- T1 Engine gearbox
- T2 Gearbox support box
- T3 Lateral drive-shaft (7,100 r.p.m.)
- T4 Aft main gearbox
- T5 Accessory gearbox (oil pumps, hydraulic pumps, cooler fan drive, generators)
- T6 Fore-and-aft drive shaft
- T7 Support bearing
- T8 Universal joint
- T9 Forward main gearbox
- T10 Forward lateral shaft
- T11 Propeller gearbox (2,590 r.p.m. output)
- T12 Gearbox oil tank
- T13 Gearbox oil supply
- T14 Oil cooler and fan
- T15 Oil cooler air exhaust

Fuel
- F1 Tank
- F2 Vent
- F3 Jettison pipe
- F4 Jettison control
- F5 Jettison pipe (extended)

General
- G1 Combustion heater
- G2 Demisting air
- G3 Cabin air
- G4 Removable nose
- G5 Rocket-assisted zero-zero ejection seat
- G6 Cast acrylic panels
- G7 Canopy open for crew entry
- G8 Canopy jack
- G9 Drop down cover/step
- G10 Access to aft fuselage
- G11 Radio and electronics installation
- G12 Rearward-retracting nosewheel
- G13 Nosewheel bay
- G14 Mainwheel bay
- G15 Main entry door
- G16 Emergency exit
- G17 Fire extinguisher
- G18 Anti-collision beacon
- G19 Navigation lights
- G20 Windscreen wiper

Instrumentation
- I1 Propeller r.p.m.
- I2 Lateral and longitudinal ASI, degrees sideslip
- I3 Circuit breakers
- I4 Duct-angle position indicators
- I5 Communication and recording controls
- I6 Starting, electrics, communications and navaids
- I7 Variable-stability system potentiometers
- I8 Low-range airspeed sensor

BELL X-22A . . .



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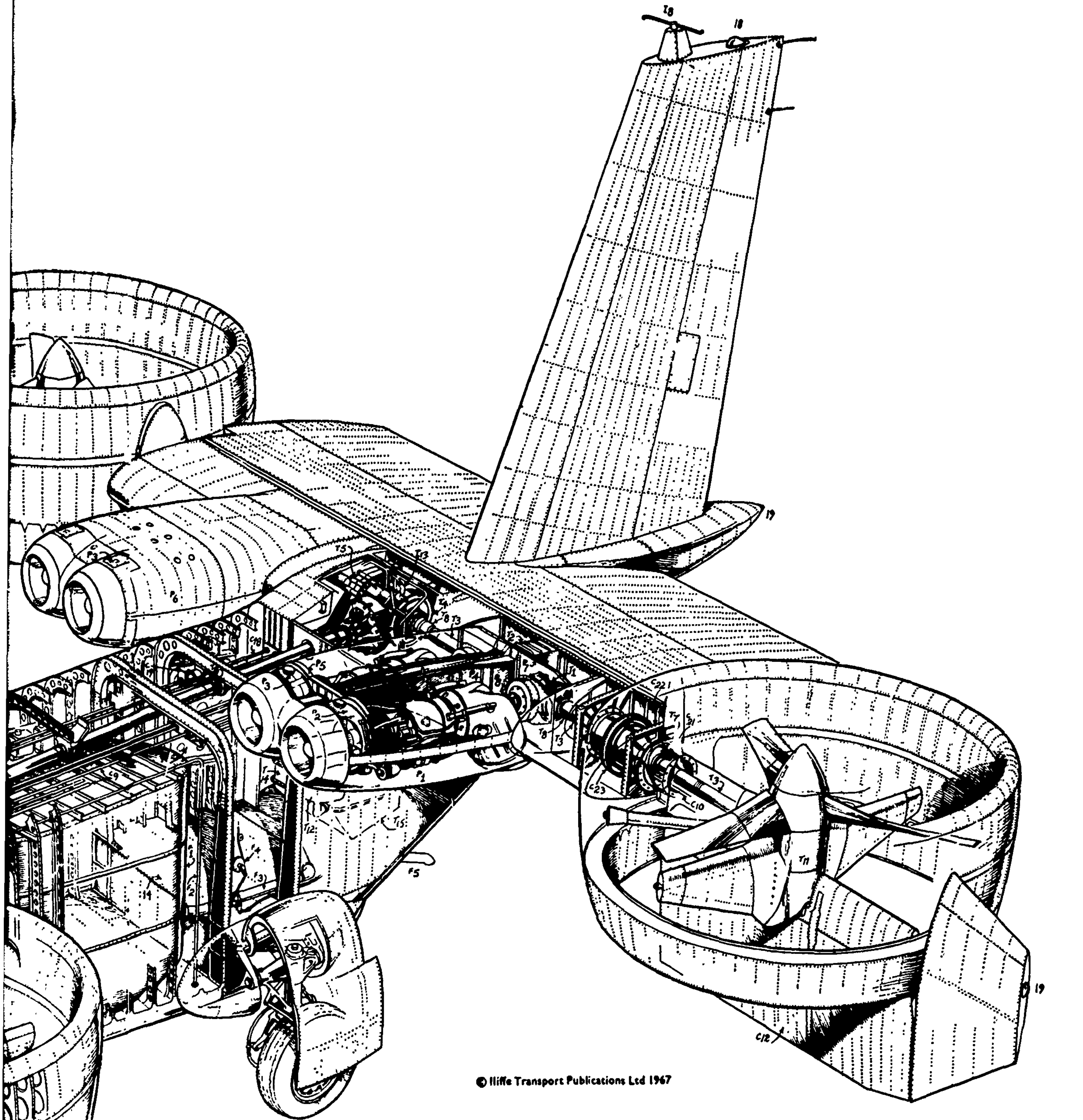

This drawing by "Flight" artist Frank Munger shows the Bell X-22A in the VTOL configuration with the shafts of the four ducted propellers aligned vertically. Also seen is the drive shaft system, with clutches and gearboxes, from the four General Electric YT58-GE-8D engines to the propellers and the harmonic drive units (shown in detail overleaf). The four ducts are geared together and rotate through 90° for transition to forward flight

C. PROGRAM INTRODUCTION

The X-22A is a V/STOL aircraft which utilizes the dual tandem ducted propeller propulsion system arrangement. As one of the Tri-Service family of V/STOL aircraft, it has been developed under the direction of the Naval Air Systems Command.

The purposes of the X-22A program are several: first, the prime goal of the contract was the demonstration of a complete transition which has been accomplished many times. Second, to provide an aircraft for future flight research and the evaluation of the unique and potentially advantageous dual tandem ducted propeller configurations. Another very important purpose emphasized by the Navy as the program developed, to provide through design specifications and program objectives, a highly versatile aircraft capable of general research on V/STOL handling qualities using a Variable Stability System designed and developed specifically for the X-22A.

Bell Aerospace has in the past successfully developed VTOL aircraft such as the Air Test Vehicle (ATV), the first jet VTOL. Success with the ATV led to a USAF contract to build the X-14 VTOL, which has been modified to the X-14A and has been flying since 1959. Further studies produced contracts for the D188A/XF-109 fighter-bomber and D190B utility and rescue aircraft which progressed to the full-size mockup stage. The Lunar Landing Research Vehicle (LLRV) and Lunar Landing Training Vehicles (LLTV) are additions to Bell's V/STOL capabilities. This background and experience has been utilized in the development of the X-22A aircraft systems.

D. X-22A PROGRAM MILESTONES

Contract Date	30 November 1962
Design Completion	January 1965
Rollout No. 1 Aircraft	May 1965
Rollout No. 2 Aircraft	October 1965
Propulsion System Test Stand	February-June 1965
Aircraft No. 2 Tie Down Test	February-May 1966

First Flight No. 1 Aircraft*	March 1966
First Flight No. 2 Aircraft	January 1967
Public V/STOL Transition Demonstration	May 1967
Completed Transition Envelope Expansion	June 1967
First Military Pilot Evaluation (MPE)	January 1968
Completed High Speed Flutter Testing	August 1968
Completed Structural Flight Test Demonstrations	August 1968
Initial Variable Stability Flight Testing	September 1968
Completed Variable Stability Flight Testing	March 1969
Final MPE	April 1969
Navy Aircraft Acceptance	19 May 1969

*No. 1 Aircraft was removed from flight status in August 1966 when damaged in landing. The Navy redirected the program to accomplish the test objectives with the one remaining aircraft.

E. DEVELOPMENT TEST PROGRAMS

1. Wind Tunnel Tests

(a) David Taylor Model Basin: 1/6 scale unpowered test in 8 x 10 ft wind tunnel.

(b) Aero-elastic powered model evaluation at DTMB.

(c) 1/3 scale ducted propeller model test in the 8 x 10 ft wind tunnel at DTMB.

(d) NASA Langley Research Center - 1/5 scale powered model in 17 foot section of 7 x 10 ft wind tunnel.

(e) Free spin model evaluation in NASA Langley spin tunnel.

(f) 0.18-scale free-flight model tested in the Langley full scale wind tunnel.

(g) Full-scale ducted propeller tests in the NASA Ames full-scale wind tunnel.

2. Airframe Static Test

The structural design of the X-22A airframe was proven by ultimate load tests of the primary structural components. The following listed major assemblies were subjected to the full ultimate design loading conditions:

(a) Engine Mount,

(b) Vertical Fin,

(c) Wing,

(d) Aft Duct,

(e) Fuselage Group,

(f) Landing Gear Installation.

No failures of primary structure occurred during the entire Static Test program and no problems were evidenced during the structural flight test demonstration program which followed.

3. Propulsion System Tests

A 150 hour Time Between Overhaul (TBO) on the entire propulsion system was approved for the X-22A based upon excellent performance during a 50 hour accelerated powered test on a complete Propulsion System Test Stand and a 50 hour Tie-down Test (PFRT) of the complete system in the No. 2 aircraft (BuNo. 151521).

Both tests were completed on the same set of transmission and propeller components. No basic redesign changes have been required as a result of either of these rigorous test programs or the flight test demonstration program which has now reached the first TBO point.

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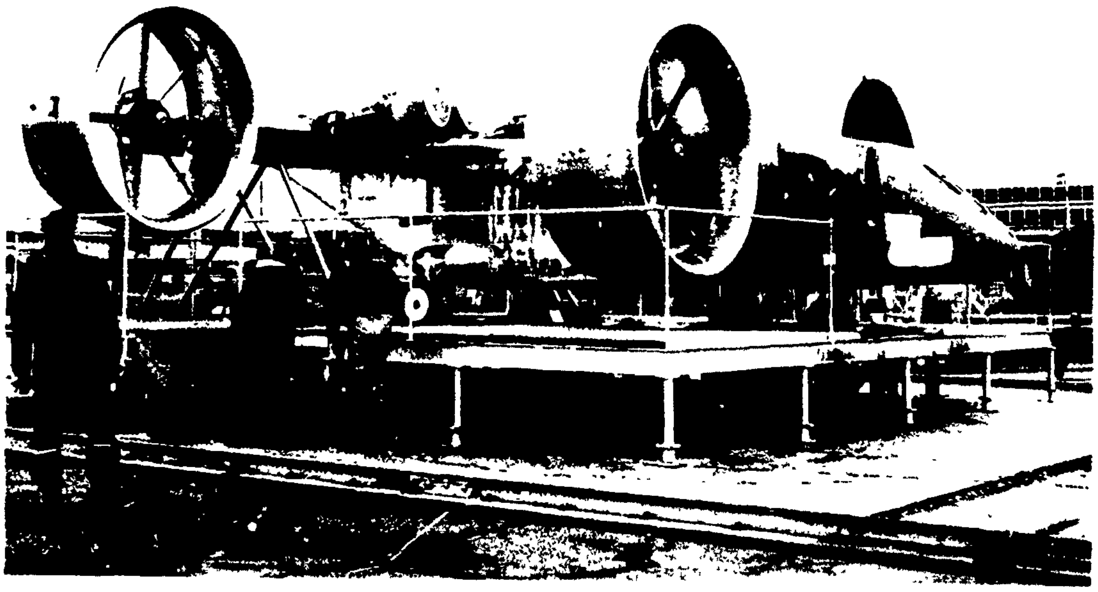
Propulsion System Test Stand



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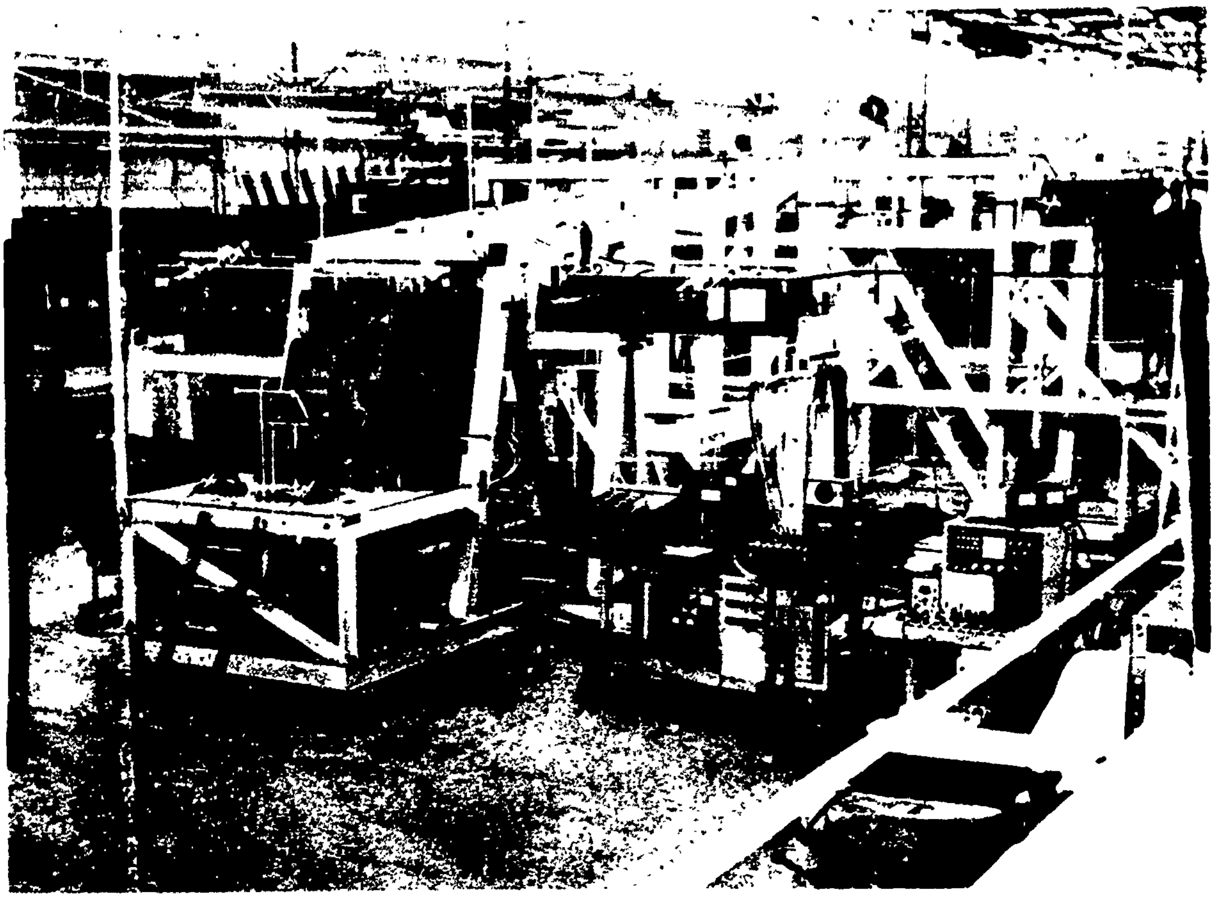
Tie-Down Test Stand

4. Control System and Hydraulic Test Stand

A complete full scale Control System Test Stand (CSTS) was constructed to develop and check out all elements of the X-22A control system including the hydraulic supply system, elevon and propeller actuation systems, duct rotation system, control phasing and stability augmentation systems, electrohydraulic feel and trim system, and the Variable Stability System (VSS). When connected with the analog simulation of the X-22A the CSTS was used to perform pilot evaluations of various failure modes during operation of the basic aircraft control system and also during variable stability operation. Several thousand hours of operation on the CSTS served to confirm the integrity of the complete system under actual operating conditions.



Control System Test Stand 204592

5. ESCAPAC 1-D-1 Ejection Seat Qualification

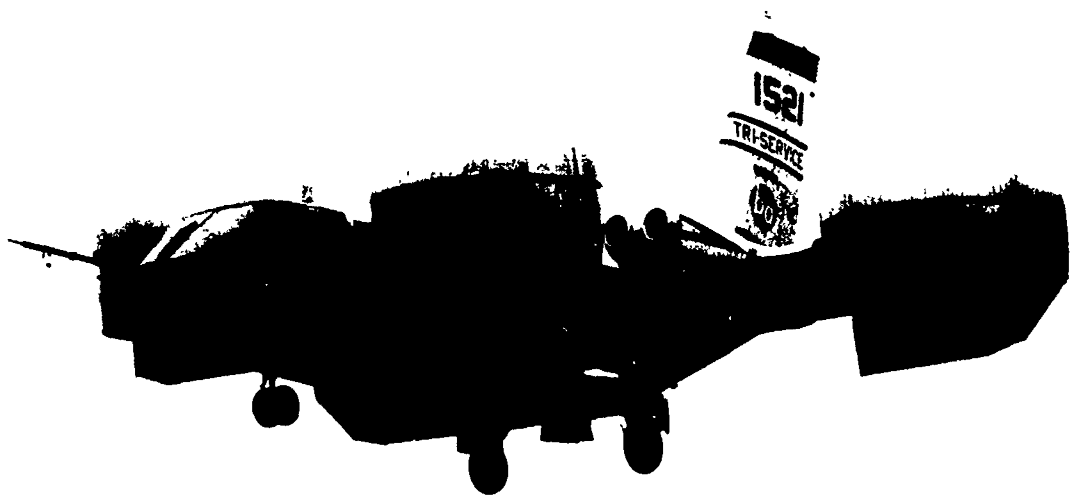
The ejection seat system for the X-22A has been qualified by a successful series of actual seat firings by Bell Aerospace and NAEC. In all, fourteen ejections were conducted, seven static ejections and seven ejections at various airspeeds (up to 250 knots). The final eight firings were conducted to qualify the seat with the DART (Directional Automatic Realignment of Trajectory) seat stabilization and snubber system installed.

6. X-22A Six Degree of Freedom Hybrid Flight Simulation

A very valuable tool developed during the X-22A program is the piloted real time six-degree-of-freedom (6 DOF) simulation of the aircraft which gives a representation of the X-22A during the complete flight envelope of hover, transition at intermediate duct angles and forward flight with ducts horizontal. The simulation was used extensively to establish control system design values of control phasing,

control sensitivity, stability augmentation, feel forces, and control harmony. The simulator was then used to familiarize and train the pilots to hover, transition and maneuver the aircraft prior to flight. A wide variety of control system failure cases were simulated for pilot evaluation and training. The Hybrid Simulation was used to familiarize the MPE pilots with the flight characteristics of the X-22A prior to the actual MPE flights.

F. FLIGHT TEST PROGRAM



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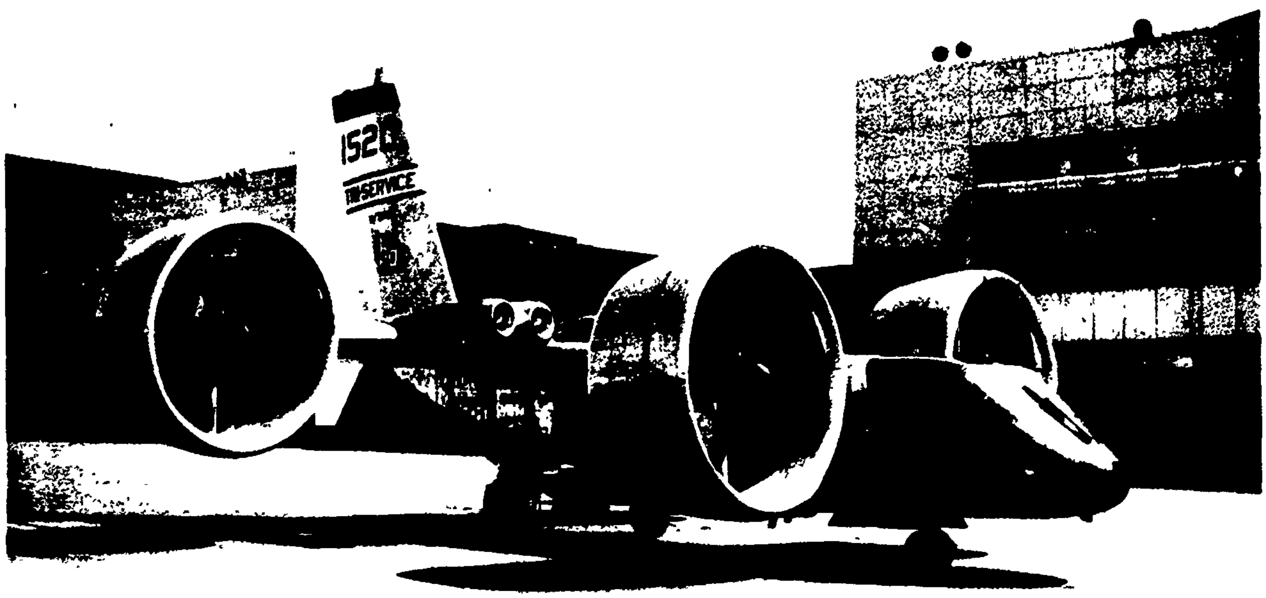
1. Contractor Flight Test Statistics (As of 19 May 1969)

Item	Total X-22A Program
Flights	220
Flight Time	113 hours
VTO	386
VL	405
Transitions	185
STO	216
SL	197
Airframe Time	430 hours

All flights were at Bell Aerospace facilities at Niagara Falls International Airport.



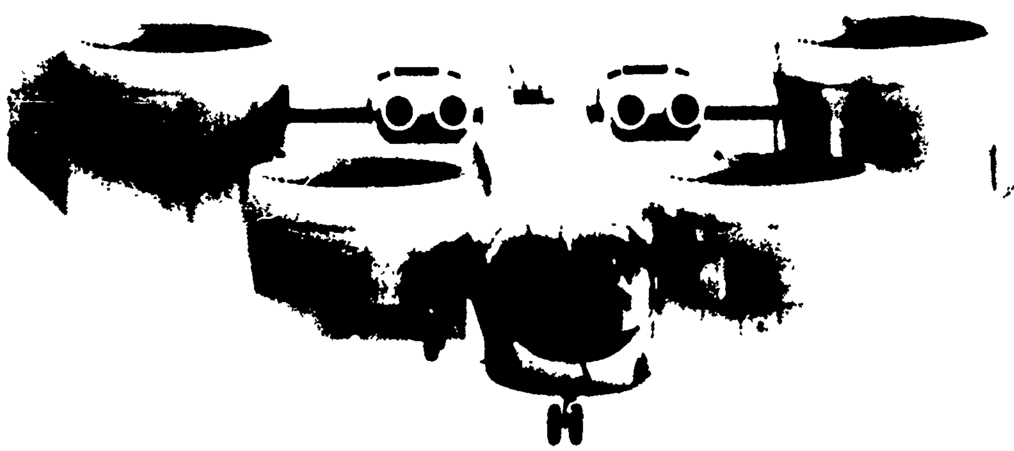
2. Chronology

a. 1966

January through December 1966 - Zero to 3.2 hours flight time: The No. 1 Aircraft was ground checked and readied for the initial X-22A hover flight. This took place on 17 March 1966 and was followed with basic systems checkout and familiarization flights. The initial STOL flight was completed 30 June and initial zero degree duct flight 22 July.

On flight 15, 8 August, a double hydraulic malfunction resulted in a hard emergency landing which damaged the aircraft. The Navy decision not to rebuild the aircraft removed it from flight status. The program in 1967 was redirected to accomplish the program objectives with the one remaining aircraft.

The initial flights were paced by the progress of the transmission system testing on the No. 2 aircraft undergoing tie-down tests. These were completed in May and the No. 2 aircraft was put in work for completion to flight status. This was essentially completed, including modifications resulting from the loss of aircraft No. 1 by the close of December 1966.

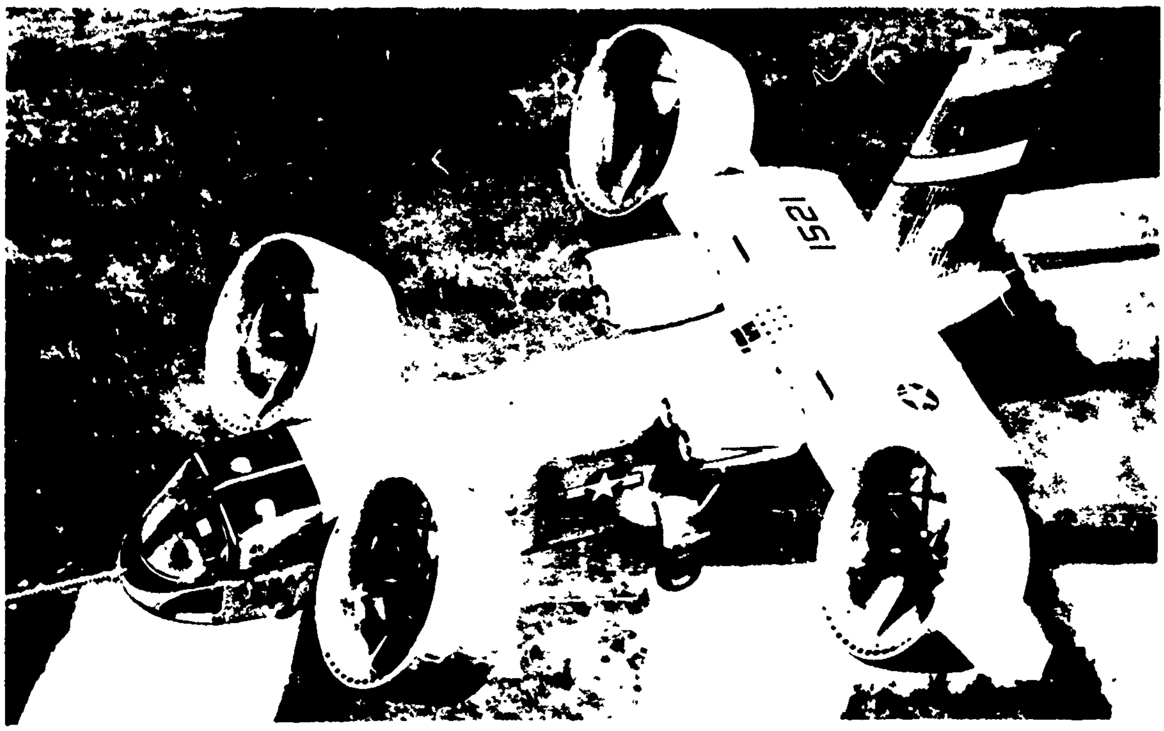


307137-55

Hovering at Altitude - Front View

b. 1967

January through March 1967 - 3.2 to 7.9 hours flight time : First Flight of Aircraft No. 2 was made 26 January 1967. During this period (ground and air) taxi, hover, transition and hover maneuver testing was accomplished. Effects of Stability Augmentation System and feel and trim system on and off were also investigated. All flights were made in the collective stick height control mode.



307137-1

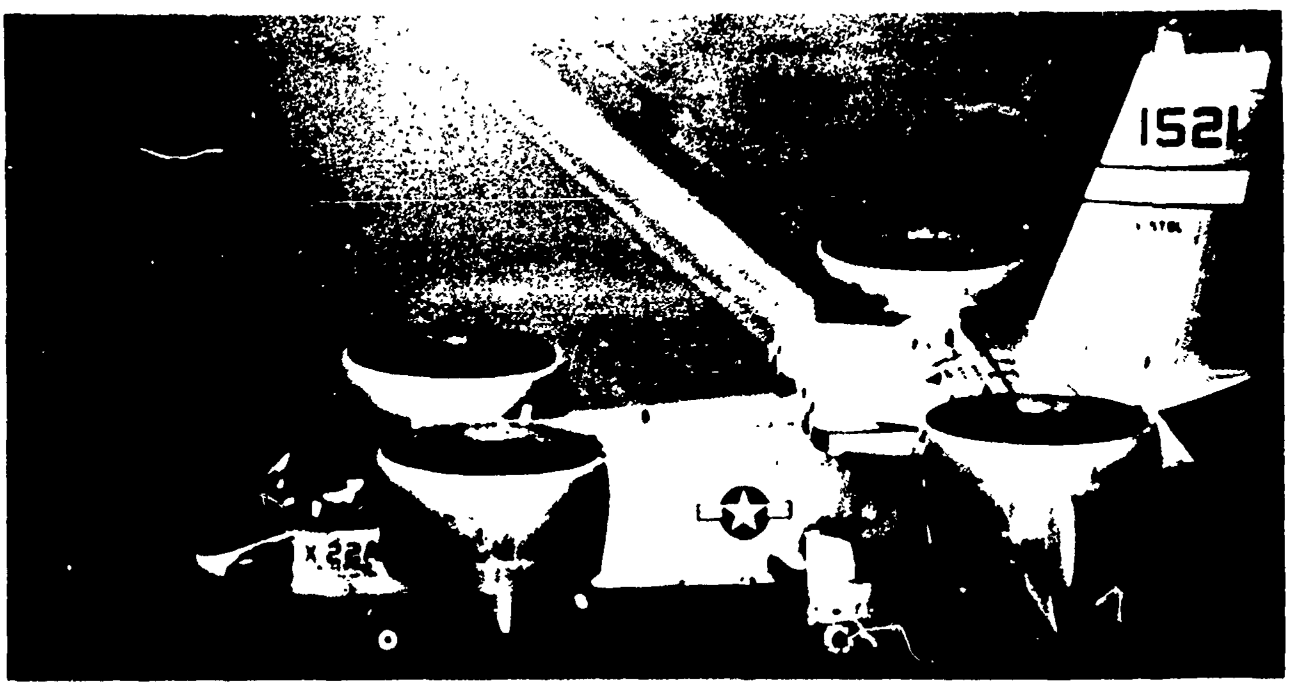
STOL Landing Approach - 30° Duct Angle

April through June 1967 - 7.9 to 21.4 hours flight time: The aircraft was cleared for 150 knot speed with landing gear down. Flights were made around the field within a five mile radius. The propeller stress survey was completed and longitudinal stability was investigated at 5000 feet altitude. STOL takeoffs and climbs to altitudes of 4500 feet were demonstrated and dynamic longitudinal stability was investigated. Evaluation of static directional and lateral stability was conducted.

Other conditions investigated were 4000 ft/min. descent, three-engine (one engine out) vertical takeoff and hover, conventional takeoff and landing, pull-ups and push-overs. VSS data flights and STOL, hover and transition proficiency flights were made. The collective (blade angle) control system was used for all above tests. Additional tests were performed in the STOL and hover modes with the power control system. A public flight demonstration of the X-22A was successfully accomplished on 9 May 1967.

July through December 1967 - 21.4 to 32.9 hours flight time: The master control was checked out and flight tests performed for evaluation. Taxi, hover, STOL, VTOL and cruise mode flights were made. Static longitudinal stability was investigated for range of speed and duct angles. Power trim change was evaluated. Continuous maximum duct rotation rate transitions from hover to conventional flight and from conventional flight back to hover were accomplished without difficulty. Landing gear cycling was performed at hover, 80, 100 and 125 knots.

In addition, military power STO, airspeed calibrations, temperature and vibration surveys, and hover tasks were performed. Structural demonstration points up to 2 g, aircraft flutter clearance out to 220 knots, and propeller blade stress surveys out to 200 knots were completed. The one-hundredth flight milestone of Aircraft No. 2 was accomplished on 19 December 1967, less than 11 months from first flight. The aircraft completed the prescribed flight demonstrations to enable the Military Preliminary Evaluation (MPE) to be scheduled during the month of January 1968.



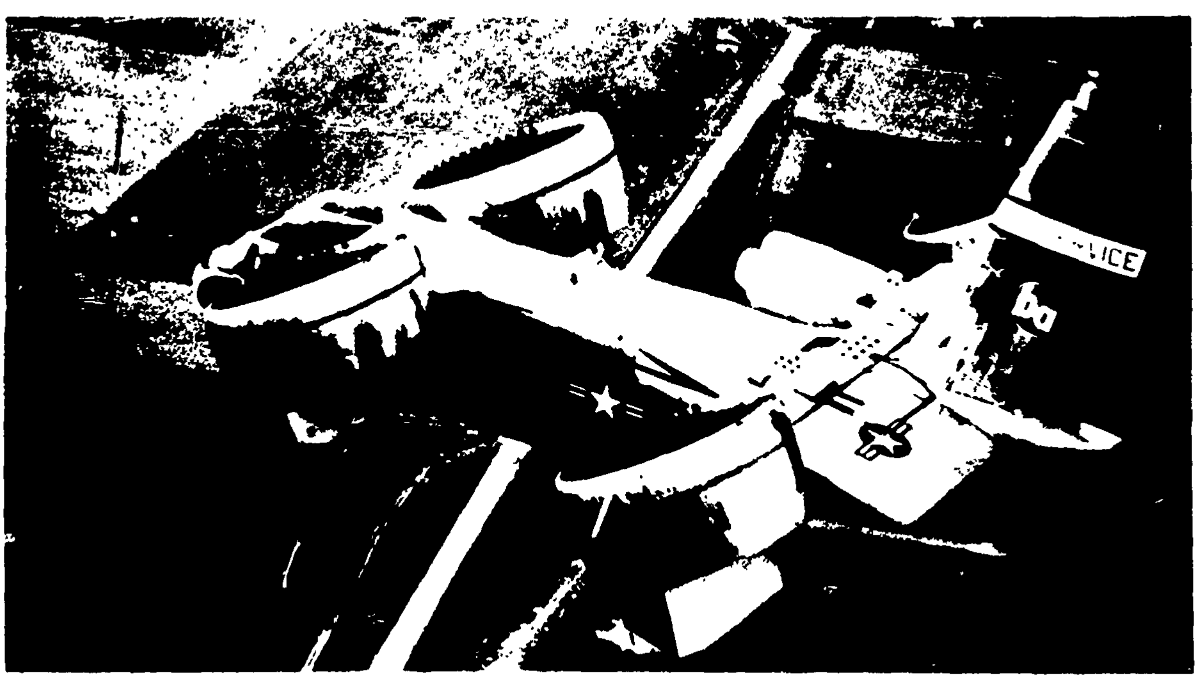
307137-62

Hovering at Altitude - Side View

c. 1968

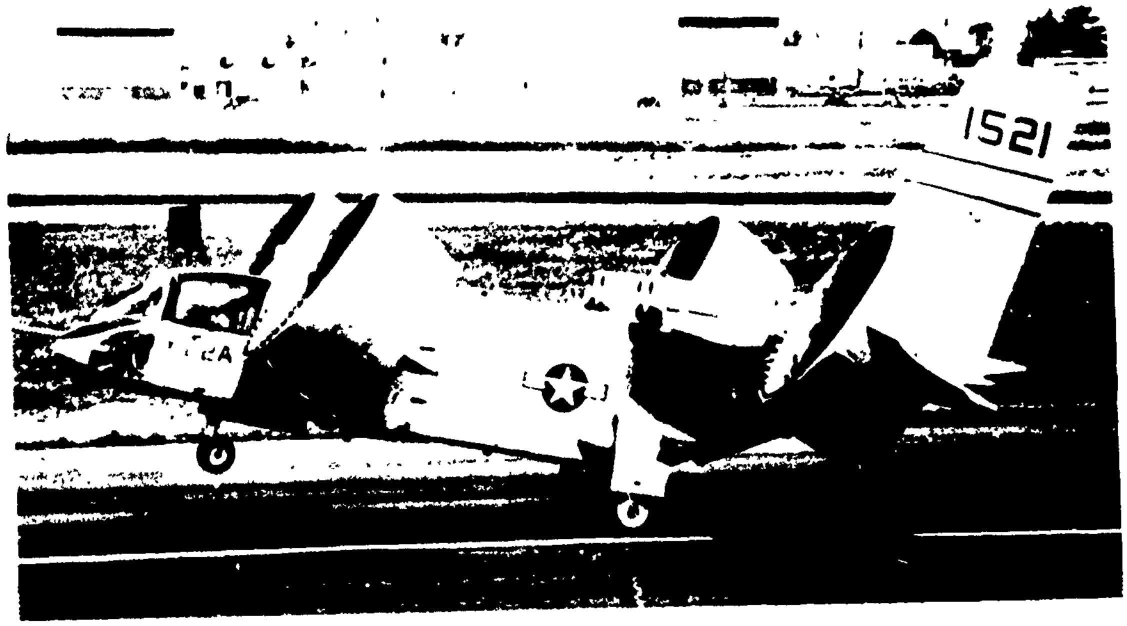
January through August 1968 - 42.9 to 73.3 hours flight time: The first MPE was initiated and completed in January 1968. It is reported in detail (10.1 hours of flying, 14 flights in 9 flying days) in Section G of this report. Immediately following the MPE, demonstration testing was resumed in the power (throttle) thrust control mode. Taxi, hover, STOL, VTOL and conventional flights were continued. Static longitudinal stability was investigated for a range of speed and duct angles. Evaluations with the electronic feel and trim system turned off were conducted to determine the flight characteristics and handling qualities in this condition. Many landings were made without the feel and trim system active. No difficulties were experienced. It was concluded that recovery from VSS maneuvers without artificial feel was practicable.

Most of the flight testing was at an airspeed greater than 150 knots for contractual structural and aerodynamic demonstration tests. The structural tests were completed up to 200 knots, zero and 2.5 g symmetrical and up to a gross weight of 16,200 pounds. The stability tests were completed through 200 knots and performance tests were completed in the cruise mode from 140 to 200 knots. Engine environmental testing was expanded to 200 knots.



VSS Tests - 75° Duct Angle

307137-43



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STOL - Short Landing - 30° Duct Angle

During flights 87-128, J. Spencer was checked out as the new Bell first pilot. By flight 151 another Bell test pilot, R. Carlin, was checked out as second pilot of the Bell team.

Minimum ground roll STOL takeoffs at maximum power were made with extremely rapid acceleration. Ground roll and steep climbout at 20-degrees nose-up attitude was attained. Aircraft rotation was made at a speed or 40 knots and a 3000 fpm rate of climb was attained while airspeed increased to a stable 60 knots during climb. Minimum ground roll STOL takeoffs were continued to decrease the distance over a 50-foot obstacle.

Performance tests to evaluate hovering ceiling were made at 300, 2000, 4000, 6000, and 8000 foot altitudes. A new hover altitude record (8000 feet) was set using the LORAS (low range airspeed system) to obtain zero airspeed. Handling characteristics were exceptionally good. Airspeed could be held exactly laterally and within ±1 knot longitudinally. Hovering at altitude on instruments was very easy using the LORAS. A simulated engine failure was demonstrated successfully while hovering at 4000 ft.

September through December 1968 - 73.3 to 81.5 hours flight time: The initial development flight tests of the X-22A VSS were made during the period with all VSS equipment installed and functioning. A number of significant milestone events were accomplished with a minimum of only minor problems encountered:

a. Successful engagement and flight in fly-by-wire (FBW) mode,

b. Transient-free engagement and disengagement of the VSS, including the elevon and propeller feed forward actuator system,

c. Initial open loop tests of the VSS,

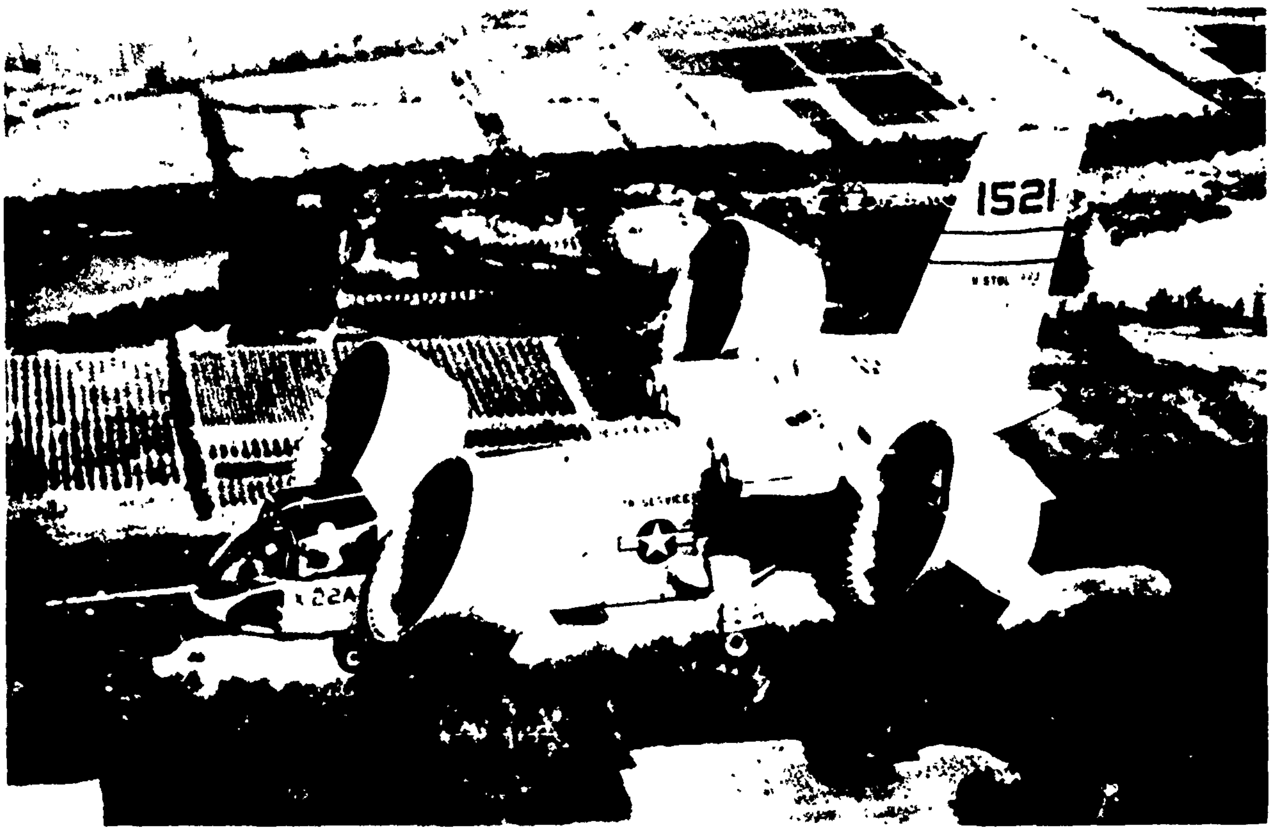
d. Initial closed loop tests of the VSS.

In addition to the VSS development, flight calibrations of the α and β vanes and the LORAS were completed. These data were required for further development and demonstration of the VSS.

Development of maximum performance short takeoff techniques was continued with an ultimately established total distance of 263 ft over 50 ft at a gross weight of 14,450 pounds. A full collective climb to 10,000 ft altitude was made, attaining a rate of climb of 4500 fpm. Various other performance, airframe and equipment demonstrations virtually completed the formal aircraft demonstration program.

d. 1969

January through May 1969 - 81.5 to 112.9 hours flight time: During this period progress was made in the development and demonstration of the VSS. The open loop tests at the 0 and 15-degree forward flight conditions were flown. Harmonic analyses of these data were completed to determine if there were any structural resonant frequencies which would affect the VSS feedback loop stability. None which would limit the operation of the VSS were found. Open loop tests at 45-degree duct angle flight conditions were completed and these data also indicated that operation of the VSS to maximum gains would be trouble-free. Open loop testing at the 90-degree duct angle hover condition was completed and subsequent analysis of these data indicate that no structural resonant conditions exist within the maximum gain limits specified for the VSS feedback parameters.



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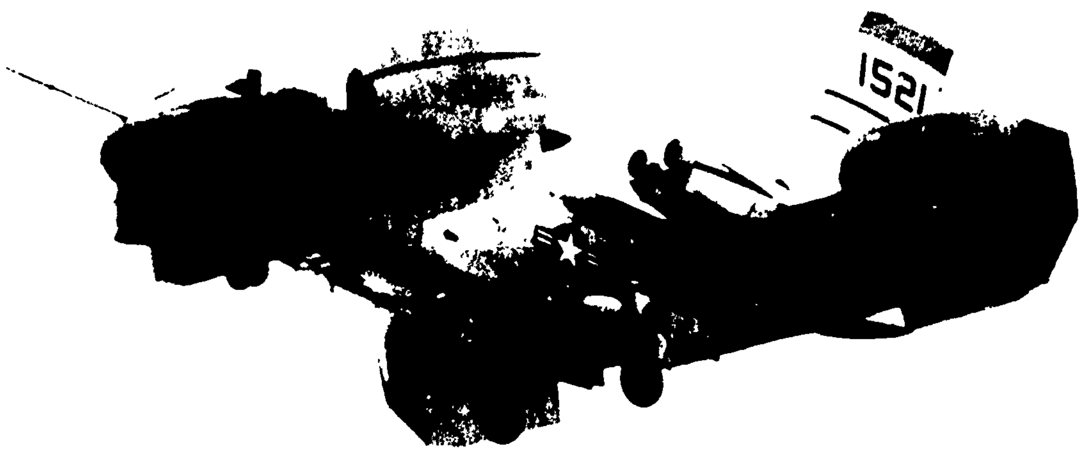
VSS Tests - 30° Duct Angle

With clearance obtained from analysis of the open loop data, closed loop tests of significant VSS feedback parameters were conducted. The majority of significant feedback parameters for the level flight condition were inserted into the aircraft control characteristics by the VSS digitrols to the maximum gain in the direction of increased aircraft stability. A number of feedback variable loops in the 90-degree hover condition were also closed. The aircraft flight characteristics were changed as expected with the pilots able to control the altered configurations encountered.

The foregoing flight characteristics cases were set up for the final MPE in April 1969. It is reported in detail (12 hours of flying, 11 flights, 6 flying days) in Section G of this report. Following the MPE the aircraft was prepared for acceptance by the Navy at Bell 19 May 1969.



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VSS Evaluations - 75° Duct Angle

3. Performance Summary

Performance Flight Demonstration Data for the completed X-22A contract tests have been furnished to the Navy in Bell Reports 2127-931002, the final being Revision G. The following tabulation represents the projected capabilities of the X-22A based upon data computed for the aircraft configured without prototype and test installations.

		Maximum Endurance Sea Level	Maximum Range At Optimum Altitude
TAKEOFF WEIGHT	lb	16,452	16,452
Fuel internal/external	lb/lb	3,196*	3,196*
Payload	lb	1,200	1,200
Stall speed - power-off	knot	98.2	98.2
Takeoff run at Sea Level - calm	ft	0	0
Takeoff run at Sea Level - 25 knot wind	ft	0	0
Takeoff to clear 50 ft - calm	ft	0	0
Rate of climb at Sea Level	fpm	4,550	4,550
Service Ceiling (100 fpm)	ft	27,000	27,000
Combat range	n.mi.	-	386
Average cruising speed	knot	-	185
Cruising altitude(s)	ft	-	11,000/15,000
Combat radius/mission time	n.mi./hr	-	186/2.3
Average cruising speed	knot	-	185
Endurance	hr	1.86	-
Average loiter speed/altitude	knot/ft	107/S.L.	-
Combat weight	lb	15,171	15,171
Engine power		Military	Military
Combat ceiling (500 fpm)	ft	27,800	27,800
Rate of climb at Sea Level	fpm	6,400	6,400
Maximum speed at Sea Level	knot	276	276
Maximum speed/altitude	knot/ft	278/10,000	278/10,000
*Maximum Internal Fuel Capacity			

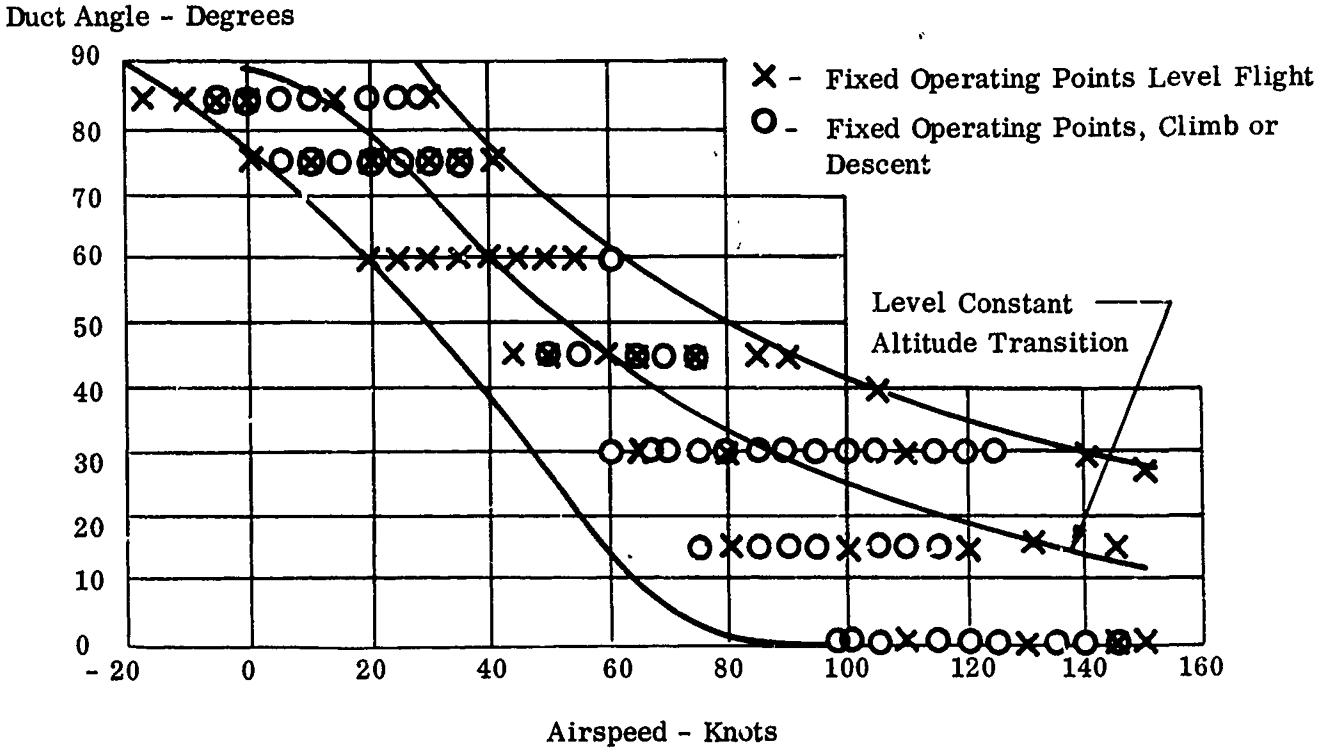
4. Performance

a. X-22A Transition Flight Envelope

The major part of the flight test program was performed with Aircraft No. 2 (Navy 151521) at gross weights from 13,900 to 16,200 pounds. The aircraft performed well in cold and hot environments and in calm and gusty wind conditions. The program was deliberate, proceeding step by step with direction and approval of the Navy Project Office. Great care was taken in performing numerous types of testing prior to flight test to assure the evident success of the flight program.

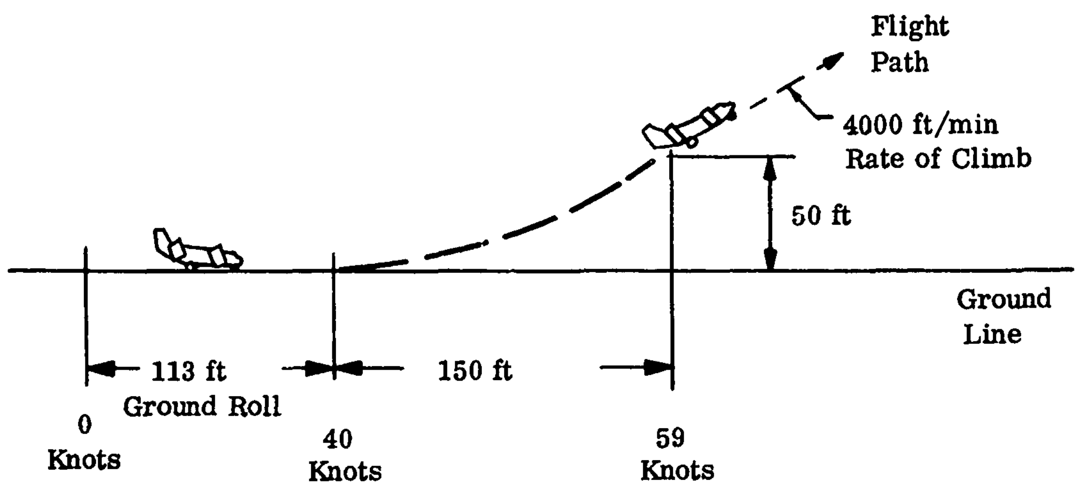
From the transition flight envelope, it can be seen that the flight conditions have permitted virtually unrestricted flight conditions throughout the attainable speed ranges for the usually more difficult high tilt angles from 45 to 90 degrees. Added flights completed the expansion of the transition envelope to all specified limits without difficulty.

The flight path for level attitude, constant altitude transitions is plotted. It is actually difficult to exceed this envelope due to the extreme attitude required. During the course of flights by both military and Bell pilots, transitions from hover to conventional flight and also from conventional flight back to hover have been easily performed at the maximum continuous duct rotation rate of 4.5 degrees per second. Slow transitions were also performed by intermittent use of duct rotation. The transitions were stopped at intermediate positions and direction reversed which illustrates the excellent handling characteristics throughout the transition envelope.



b. Short Takeoff

STOL at all duct angles have been performed and no operational limitations exist.



Profile of a Typical Maximum Performance Short Take-Off

Duct Angle 30°
Gross Weight 14,450 lbs

c. Terminal Area Operatic..s

Steep descent path landing approach angles exceeding 20 degrees at all the selected duct angles, and fully controlled vertical descents exceeding 1600 feet per minute have been flown. The positive control exhibited by the X-22A at all speeds and duct angles throughout the extremely large transition envelope all the way down to the runway is very impressive. These capabilities coupled with the use of the Variable Stability System to vary flight characteristics make the X-22A uniquely suited for terminal area operations investigations. (See Figure 4.)

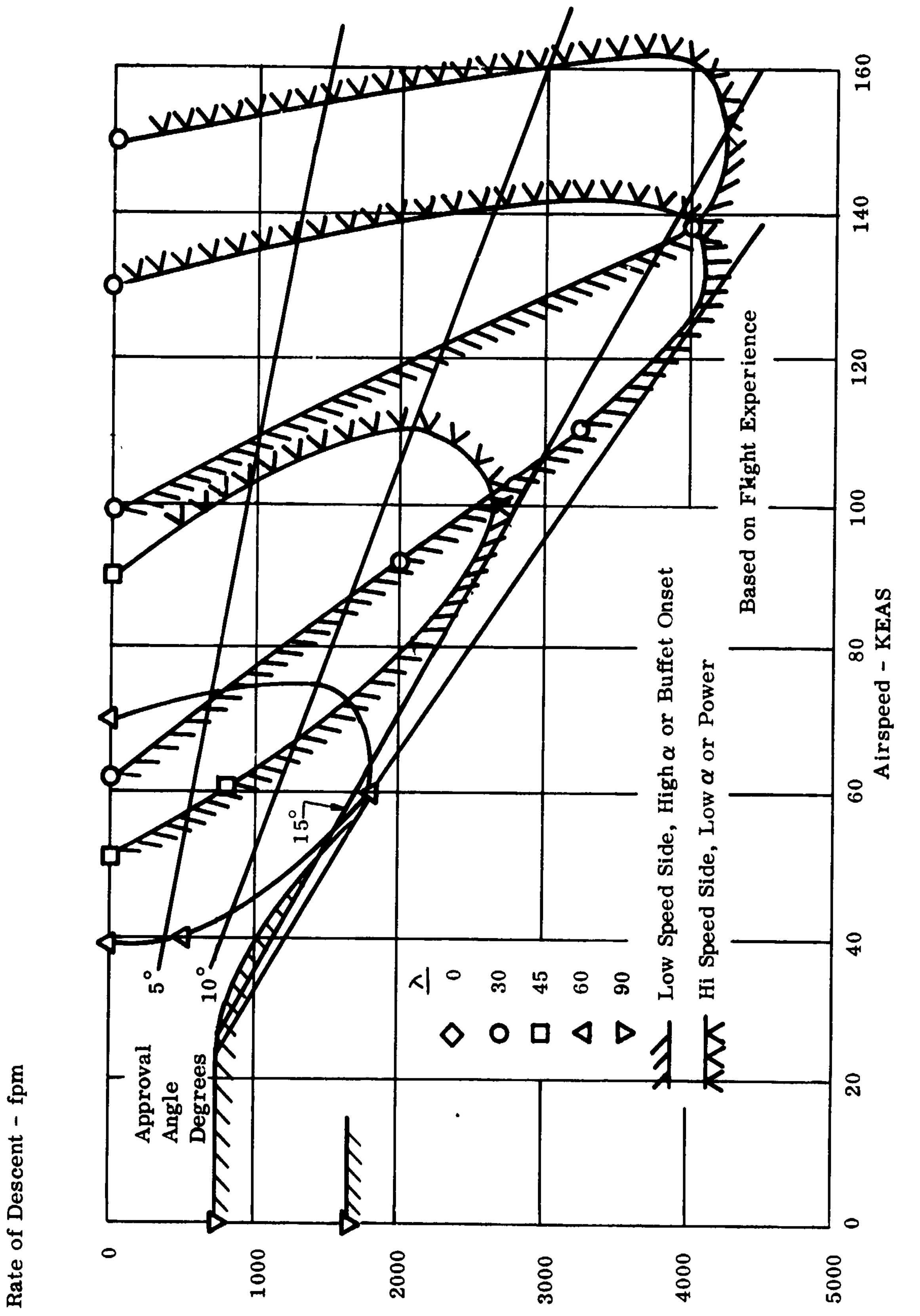


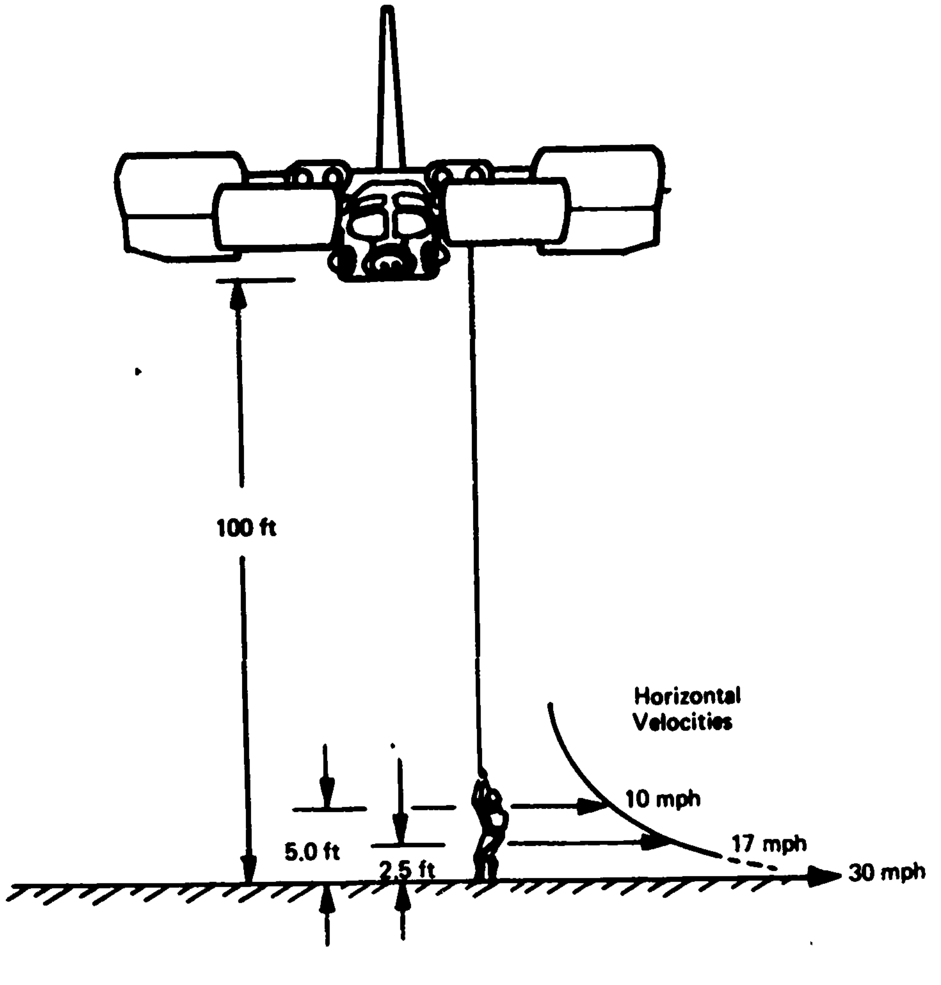
Figure 4. Rate of Descent Characteristics

d. Downwash Characteristics

Downwash was measured under the X-22A in hovering flight. Measurements were confirmed by previous model tests and surveys.

The flight test measurements show that a nominal hover heights of 50 to 100 feet, downwash characteristics are reasonable. The aircraft has a unique four element slipstream and ground impingement flow system. A feature of this flow system is the area of relatively still air (with some updraft and/or outflow) under the aircraft in the region of confluence of the radial flows from the fans' impinging slipstreams.

With the aircraft hovering at 100 feet, the test engineer had no difficulty in moving about under the aircraft. At both 50 and 100 feet hover altitudes, a region of very low velocity, almost near calm, was reported directly under the aircraft.



Downwash Characteristics of the X-22A Aircraft

e. Noise Characteristics

Far noise field measurements were performed with the aircraft hovering about 50 feet over the runway. With the fuselage of the airplane aligned perpendicularly to the direction to the microphone, the sound pressure levels listed were measured.

Far Field Sound Pressure Levels Generated by the X-22A in Hover, at a Distance of 500 ft (in db re 2 x 10^{-4} Microbar) From a Microphone				
Test Flight	prpm	Propeller Blade Angle (deg)	Total Shaft Horsepower (hp)	Overall Sound Pressure Level (db)
1	2535	23	3400	102
2	2650	22	3400	104
3	2600	22	3200	100
4	2660	21	3120	102
The average sound pressure level is 102 db.				

On a VTOL aircraft using dual tandem free (unducted) propellers running at the same thrust and tip Mach number, propellers of approximately 20 feet in diameter would be required to keep the noise level down to the above low values.

f. Variable Stability Flight

(1) Bell X-22A VSS Accomplishments

The X-22A Variable Stability System (VSS) development and demonstration program was initiated in September 1968. Fifty-two flights were made to develop and demonstrate the system including a Military Evaluation of VSS capabilities in early April 1969. During these flights, 25 hours of VSS operation were logged with over 300 VSS engagements in flight.

After installation of the VSS equipment, extensive ground checking and calibrations were performed of all sensors, basic flight controls, feed forward system, safety monitors, and the VSS equipment.

To check the system for stability when fitted to the airframe, open loop tests were performed. This was accomplished by engaging the VSS with the feedback parameter gains set to zero. The system feedback outputs were recorded and analyzed in response to abrupt control inputs to determine over what range of gains feedback loops could be closed. These tests were performed at 0° and 90° duct angles with spot checks made at intermediate duct angles.

Following this analysis, the significant feedback parameter loops were closed and gains incrementally increased one parameter at a time. The results of these tests were compared with the open loop data before progressing to the maximum specified gains. Following these tests, combinations of feedback parameters were incorporated to change specific dynamic characteristics as a final system demonstration.

The contract demonstrations were completed in April 1969 with a very successful MPE in which the participating pilots acted as evaluation pilots and experienced the wide spectrum of stability and control and handling qualities produced by the VSS equipment. The following page lists all of the feedback variables provided in the VSS.

Five military pilots accomplished this evaluation during eleven flights, totaling twelve hours of flight time, within six working days.

The X-22A has made 220 development flights and, with its VSS, is a well developed research tool with very few operational limitations throughout a flight envelope from zero to 200 knots. Bell has a continuing effort to develop better methods of utilizing the equipment through modern computer analysis techniques. A preliminary effort has yielded a method which shows great promise in being applicable to the computation of the feedback gains. Due to the large number of feedback signals, all combinations of available gains will never be completely evaluated but as research

programs progress, additional knowledge of system characteristics will continuously be gathered making the tool more useful.

(2) VSS Feedback Variables

Aerodynamic Derivatives:

L_v, L_β, L_p, L_φ, L_r,

M_w, M_α, $M_{\dot\alpha}$, M_q, M_θ, M_w, M_u,

N_v, N_β, $N_{\dot\beta}$, N_p, N_ψ, N_r, N_φ

Control Input Couplings and Dampings:

Thrust due to elevator stick displacement

Thrust due to duct angle

Thrust due to aileron stick displacement

Yaw due to aileron stick

Roll due to yaw control

Pitching moment with duct angle

Height damping in hover

Thrust lag

Control System Characteristics:

Stick and rudder gearings

Stick and rudder force gradients

Stick and rudder breakout forces

Stick force gradient change with pitch acceleration

Selection of force or position stick commands

Variable trim rates

Selection of rate or instantaneous trim

5. Summary of Pilot Comment

a. VTOL and Hover Operation

The airplane exhibits very good positive static and dynamic stability in hover out of ground effect and can be flown hands off for long periods. It has excellent control response about all axes and has good height control. Ground effect is positive, mildly turbulent. Vertical takeoffs and landings are easily performed. All hovering maneuvers are much easier to perform than in most helicopters. Various fuselage attitudes can be maintained as a function of the hovering duct angle selected while hovering.

b. STOL Operation

Thirty-degree duct angle takeoffs and landings are accomplished with ease within the 90 degree crosswind limitations of the airplane of 15 knots. Touchdown attitude of approximately 5 degrees affords excellent visibility. There is no tendency to swerve with the ground roll nearly straight. Without the benefit of nose wheel steering, takeoffs and landings have been made at various duct angles between 0 and 90 degrees. Accurate landing touchdown points are the rule rather than the exception. Duct rotation is used after landing to eliminate residual thrust and to obtain aerodynamic braking.

c. Conventional Flight

The aircraft has good handling characteristics with very crisp response about all axes even though the static stability is neutral to slightly negative. The characteristics are comparable to a high performance fighter aircraft. Flying without Stability Augmentation System (SAS) and without Feel and Trim presents no difficulty.

d. Transition

Flying the aircraft within the transition envelope is very comfortable. Duct rotation is used simply as another flight control to change speed or adjust fuselage attitude at constant speed. There are no special procedures or schedules to be complied with when transitioning. Ducts can be rotated in either direction at the pilot's discretion to obtain the desired response.

e. Stability Augmentation System

The rate stabilization system of the airplane assists the pilot immensely in the hover and transition modes of flight. Hovering has satisfactorily been accomplished without SAS although the pilot workload is increased. STOL landings without SAS are accomplished with ease.

f. Ground Effect

Ground effect is mildly turbulent, but positive. A slight loss in yaw control power is noticed while hovering in ground effect. At certain combinations of duct angles and wind speeds, ground effect dissipates and disappears.

g. Control Mode (Collective)

Control of power is linear and power response is excellent. Power management is good in forward flight and altitude control is excellent in hover.

h. Control Mode (Power)

No noticeable or adverse reaction is apparent while moving a handful of throttles versus a single collective pitch stick to perform a vertical takeoff or landing. A longer time constant makes altitude control in the hover slightly difficult but power control in forward flight is conventional with no difficulties experienced.

i. Variable Stability Operation

(1) Engagement to fly-by-wire (FBW) or VSS modes is easily accomplished and transient free.

(2) Flight characteristics in FBW mode appear comparable to the basic X-22A control system mode.

(3) The unaltered (zero feedback gains) VSS mode is identical to the basic X-22A except for the faster response of a tighter control system.

(4) The VSS safety monitor system will trip the VSS out and revert control to the safety pilot if certain preset limits are exceeded or a failure is detected.

(5) The insertion of variable feedback parameters can drastically alter the flight characteristics of the X-22A.

G. MILITARY PILOT EVALUATIONS

1. Phase I MPE - (3 January 1968 through 31 January 1968)

The first Military Preliminary Evaluation team, consisting of 13 pilots and engineers from the three services, arrived at Bell on 3 January 1968, for one week of Ground School and Simulator Training to preceed flying.

The evaluation flying proceeded rapidly with the only major delays due to weather. The crew on the first three flights was composed of one military and one Bell Aerosystems pilot. During the remaining eleven flights of the evaluation, full military crews operated the X-22A. Five military pilots accomplished the evaluation during the fourteen flights totaling approximately ten hours of flight time.

With the extensive instrumentation available on the X-22A, the evaluation team was able to obtain very complete information on the static and dynamic stability characteristics of the aircraft throughout transition envelope. These are the flight regimes in which the X-22A will be used to perform its basic VTOL research mission using the Variable Stability System. Comments received indicated that the aircraft was meeting its design requirements and is very well suited for this research role.

First Military Pilot Evaluation Flights

(11 - 31 January 1968)

Total Flights		14
Total Flight Time		10:08
Total VTO		25
Total VL		24
Total Transitions		31
Total STO		5
Total SL		6
Pilots	Lt. Comdr. W. Davies, USN	
	Maj. W. Rundgren, USA	
	Maj. J. Basquez, USAF	
	Lt. D. Green, USN	
	Lt. W. Casey, USN	

2. Phase II MPE (31 March 1969 through 9 April 1969) (Final)*

The second Military Preliminary Evaluation team consisted of five pilots from all branches of service. Its purpose was to evaluate the Variable Stability System capabilities of the X-22A aircraft. After a two-day ground school, flight testing was conducted on a two-flights-a-day basis over a six-day period. All flights except one were flown with a military pilot as evaluation pilot and a Bell pilot as safety pilot. The one exception was flown with military pilots as both evaluation and safety pilots.

Variable stability parameters were varied to provide a total of 18 different configurations at duct angles of 0°, 30°, 45°, and 90°. Individual parameters were changed to the limits of the pilot's capability to control the aircraft in the unstable direction and to the specification limits or maximum gain available in the stable direction. The successful results of the MPE demonstrated the ability of the VSS to markedly change the basic characteristics of the X-22A, and to prove its potential as a research tool in the V/STOL field.

Second Military Pilot Evaluation Flights

(2 - 9 April 1969)

Total Flights		11
Total Flight Time		12 hours
Total VTO		6
Total VL		9
Total Transitions		23
Total STO		12
Total SL		9
Pilots	Maj. W. Scheuren, USMC	
	Lt. Col. B. Choat, USA	
	Maj. W. Rundgren, USA	
	Maj. E. Flanigen, USAF	
	LCDR. P. Hine, USN	

*Reported in detail in following Section III Test Program pages

III. TEST PROGRAMS

A. FLIGHT TEST AND OPERATIONS

1. BuNo. 151520 (Bell No. 1 Aircraft)

The airframe and components of the damaged aircraft had remained consolidated and covered in the Bell Aerospace Company hangar since August 1966. As reported in prior progress reports a proposal was prepared and transmitted to NAVAIR in January 1969. An early authorization was anticipated to accomplish this disassembly and salvage of the possible spares for the aircraft in parallel with the remaining flight test operations activity. The proposal continued under review at NAVAIR until late in May at which time direction was received for Bell to initiate work.

At this writing, the inventory of salvaged parts is being prepared for contract conclusion. Items relegated to scrap have been disposed of. The salvaged parts are identified and stored, to be available for inspection, reconditioning and overhauling if required for future flight use.

2. BuNo. 151521 (Bell No. 2 Aircraft)

During this reporting period, prior to aircraft delivery, the X-22A BuNo. 151521 made twelve flights. Flight time was 12 hours 43 minutes, total running time was 19.1 hours. Thirteen STO takeoffs, ten STOL landings, six VTO takeoffs, nine VTOL landings and twenty-five transitions were performed. Total program flight time at 19 May delivery was 109.7 hours.

a. Flight Test Accomplished and MPE Flights

Eleven of the twelve flights during this period were made as the Military Preliminary Evaluation to conclude the X-22A flight test demonstration program. Prior to these flights a single Bell flight was made to confirm variable stability system fixed operating point demonstrations for the MPE.

Flight 2F194 was flown on 1 April to check variable stability fixed operating point demonstrations planned for the MPE and checkout the aircraft after minor rework and inspections performed prior to the MPE.

MPE ground school was conducted on 31 March and 1 April for a group comprising five pilots and four engineers. The team for ground school and for flight is listed below:

MPE TEAM FOR FINAL EVALUATION*

31 MARCH THROUGH 11 APRIL 1969

Major W. J. Scheuren	USMC	NAVAIRTESTCEN
LCDR P. M. Hine	USN	NAVAIRTESTCEN
Mr. Samuel L. Porter	Engineer	NAVAIRTESTCEN
Mr. R. L. Traskos	Engineer	NAVAIRTESTCEN
Major W. Rundgren	USA	ATA
Lt. Col. B. J. Choat	USA	USA AVLABS
Mr. Richard I. Adams	Engineer	USA AVLABS
Major E. G. Flanigen	USAF	AFFTC
Mr. John Snoderly	Engineer	NAVAIRSYSCOM

*(See Figure 5.)

MPE flights commenced on 2 April (delayed until early afternoon by poor weather), and continued through 9 April, making eleven flights in six flying days totaling 12.0 hours of flying.

The variable stability system demonstration flights were divided into three phases which covered variable stability and fly-by-wire operation at 0°, 30°, 45° and 90° duct angle. Two of the MPE pilots evaluated all three phases. A third cycle of the three phases was shared by the two Army pilots. Flight No. 11 was a composite flight performed by the last MPE pilot made up of the most significant portions of each phase. Each of these flights were made with a Bell pilot acting as safety pilot. An evaluation was made of the safety pilot's function on Flight No. 5 by Major Rundgren, who was the only member of the team to have flown in the first MPE. Pilot flight time in the X-22A varied from 4 hours 4 minutes for the team leader, Major Scheuren, to 1 hour 6 minutes. (See Figure 6.)

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Figure 5. Phase II (Final) MPE Team
(R. Traskos, LCDR P. M. Hine, Lt. Col. B. Choat, Maj. E. Flanigen, Maj. W. Scheuren
Maj. W. Rundgren, R. Adams, S. Porter, and J. Snoderly)

Flight No.		Date	Flight Time		VTO	VL	STO	SL	Trans	Safety Pilot / Eval. Pilot	Takeoff Gross Weight	Flight Summary
Bell	MPE		hr: min	Cum hr min	No/ Cum	No/ Cum	No/ Cum	No/ Cum	No/ Cum			
2F195-431	1	2 April 69	1:03	1:03	0/0	0/0	1/1	1/1	4/4	Spencer Rundgren	16500	MPE Phase II, 45 and 90° λ VSS Demo.
2F196-432	2	3 April 69	1:04	2:07	0/0	0/0	1/2	1/2	0/4	Spencer Scheuren	16500	MPE Phase I, 0° λ VSS Demo.
2F197-433	3	3 April 69	1:17	3:24	2/2	2/2	1/3	1/3	6/10	Spencer Flanigen	16500	MPE Phase III, 30 and 90° λ VSS Demo.
2F198-435	4	4 April 69	1:07	4:31	3/5	4/6	1/4	0/3	4/14	Spencer Scheuren	16500	MPE Phase II, 45 and 90° λ VSS Demo.
2F199-436	5	4 April 69	0:37	5:08	0/5	0/6	1/5	1/4	0/14	Rundgren Scheuren	15700	Safety Pilot Evaluation
2F200-437	6	7 April 69	1:00	6:08	0/5	0/6	1/6	1/5	0/14	Spencer Rundgren	16500	MPE Phase I, 0° λ VSS Demo.
2F201-438	7	7 April 69	1:03	7:11	0/5	0/6	1/7	1/5	0/14	Spencer Flanigen	16500	MPE Phase I, 0° λ VSS Demo.
2F202-439	8	8 April 69	1:20	8:31	1/6	2/8	1/8	0/6	3/17	Spencer Choat	16500	MPE Phase III, 30 and 90° λ VSS Demo.
2F203-440	9	8 April 69	1:16	9:47	0/6	0/8	1/9	1/7	2/19	Spencer Scheuren	16500	MPE Phase III, 30 and 90° λ VSS Demo.
2F204-441	10	9 April 69	1:07	10:54	0/6	0/8	1/10	1/8	2/21	Spencer Flanigen	16500	MPE Phase II, 45 and 90° λ VSS Demo.
2F205-442	11	9 April 69	1:06	12:00	0/6	1/9	2/12	1/9	2/23	Spencer Hine	16500	MPE Composite, 45 and 0° λ VSS Demo.

Figure 6. X-22A MPE II Flight Test

As noted in the previous progress report, Bell set up a series of demonstrations of modifications of aircraft stability and handling characteristics for the evaluation. MPE pilots flew the X-22A from the left-hand pilot's seat as variable stability evaluation pilots with a Bell safety pilot. Using fly-by-wire and variable stability modes of variable stability system operation, the evaluation pilot was able to compare aircraft flight characteristics of the basic aircraft on fly-by-wire with SAS operating to the characteristics as modified by variable stability.

The variable stability system was adjusted to vary the longitudinal and lateral/directional stability characteristics of the aircraft at 0°, 45° and 90° duct angle. At 30° duct angle the flight control force and gearing characteristics were demonstrated by varying from low force gradient position control through to rigid control, force command control mode. During the MPE pilot evaluation of the right-hand safety pilot function, the variable stability system was cycled on and off with the safety pilot recovering the aircraft with feel and trim off and SAS on and off.

The Bell safety pilot demonstrated one-half SAS with feel and trim off VTOL landings and takeoffs, SAS off with feel and trim off STOL landings, and various STOL and VTOL takeoff and landing procedures.

All MPE flights were monitored by a combined Bell/MPE engineering team using the telemetry ground station on-line data readout. Test maneuvers were evaluated from these test data and procedures were modified by the test engineer over the radio loop to the test pilot.

After eleven MPE flights, the MPE team had acquired sufficient data and experience to terminate the MPE flying with two days remaining of the planned MPE period.

b. Post MPE Critique

The MPE critique was held Friday, 11 April. It was brief with no major discrepancies noted. Most discrepant items were a repeat of those of Phase I MPE. Since Phase I, with no direction to make any corrections or changes, Bell only accomplished those changes required for design, maintenance or safety of flight reasons.

Major W. Scheuren, the MPE leader, discussed the X-22A features which enhanced its usefulness, the deficiencies which prohibit satisfactory or safe accomplishment of V/STOL flying qualities research, or which limit mission effectiveness and which future designs should avoid.

Bell discussed the foregoing critique with NAVAIR in Washington 16 April. They understood the actions taken and the good reasons for the various "deficiencies" noted. The critique is summarized in NAVAIRTESTCEN 28 May 1969 Report No. FT-47R-69.

c. Preparation for Delivery

At the foregoing NAVAIR post MPE conference, planning toward aircraft delivery was discussed. To comply with NAVAIR schedules, the delivery date was slipped two weeks from the second to the sixteenth of May. It was pointed out that such change stretched out the work and, with limited funding, the hangar work force would necessarily be reduced to one shift. This was done, and conditioning and readying the aircraft for delivery was performed to the target date.

Subsequent discussions leading to the delivery changed the date to Monday, 19 May, for the Navy acceptance ceremony. On the morning of 19 May, actual contractual acceptance of the aircraft was completed through the local DCASO office. At 1 PM, five Navy visitors and other Government and Bell personnel met for a formal acceptance ceremony in the Flight Hangar. The Government representatives were:

NAVAIR Personnel	DCAS Personnel
Captain Rodney F. Schall, USN Executive Director Research & Technology	Colonel Robert J. Hagreen, USAF Commander, DCASD, Rochester, N.Y.
Captain Harry L. Benson, USN Head of Plans & Programs Division	Lt. Commander Nathan C. Holway Chief, DCASO, Buffalo, N.Y.
Commander Frederick Highsmith, USN X-22A Project Officer	Mr. Walter Kubisty Chief Quality Assurance
Mr. Gerald L. Desmond Technical Administrator Aerodynamic & Structures	Mr. Michael J. Cullinan Quality Assurance Representative
Mr. Harold Andrews Section Head Stability & Control	

The ceremony, witnessed by approximately 100, was conducted by Mr. N.C. Willcox, Bell Vice President. Bell President, Mr. W.G. Gisel, welcomed the gathering (see Figure 7); Captain R.F. Schall spoke for the Navy acceptance and related the planned role of the X-22A; Cmdr. F. Highsmith and Col. R.J. Hagreen expressed pertinent remarks representative of their offices. (Figures 8, 9, and 10.)

d. Aircraft Activity Following Delivery

In view of the delays leading to the planned post delivery new contract for pilot training and evaluation flying, a short term "live" storage procedure was authorized for the upkeep of the aircraft. Three run-ups at two week intervals were planned. The first run-up was performed on 29 May.

During the seven week Bell strike period the aircraft was periodically checked by supervision. Due to a leaking landing gear strut and a propeller hydraulic leak, preventive measures were taken. On three separate occasions, the systems were energetically cycled in the hangar to minimize and prevent any storage "setup". Following the strike period, a complete live storage cycling was accomplished. This effort was immediately followed by new contract work authorization to ready the aircraft for the pilot training and evaluation flying. The X-22A aircraft was supplied to this new contract as GFE. Reporting for this, a separate new contract, was covered under weekly letter type reporting to NAVAIR, AIR-320.

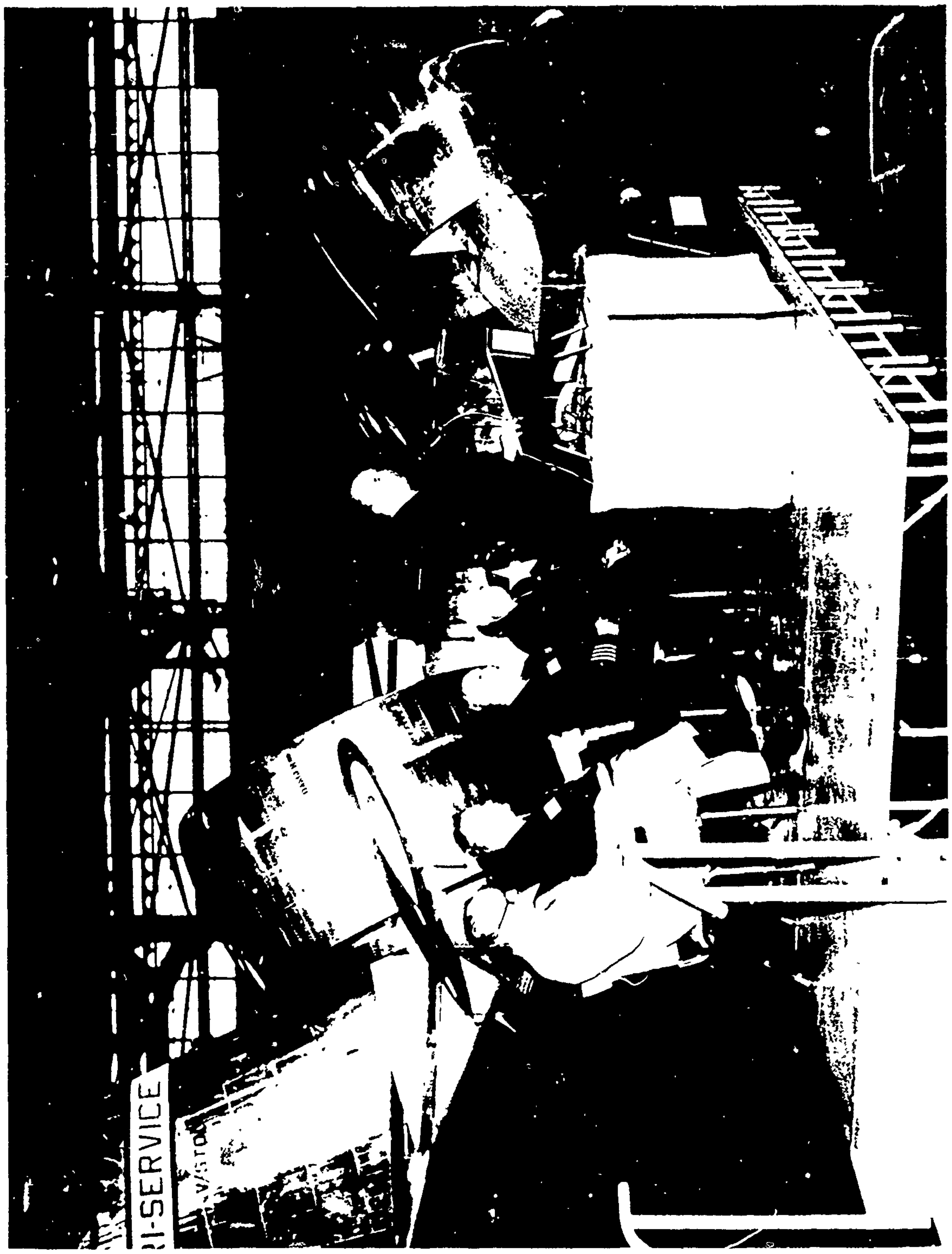

Figure 7. Acceptance Speakers

(N. C. Willcox, Cdr F. Highsmith, Capt R. Schall, Col. R. Hagreen and W. G. Gisel)

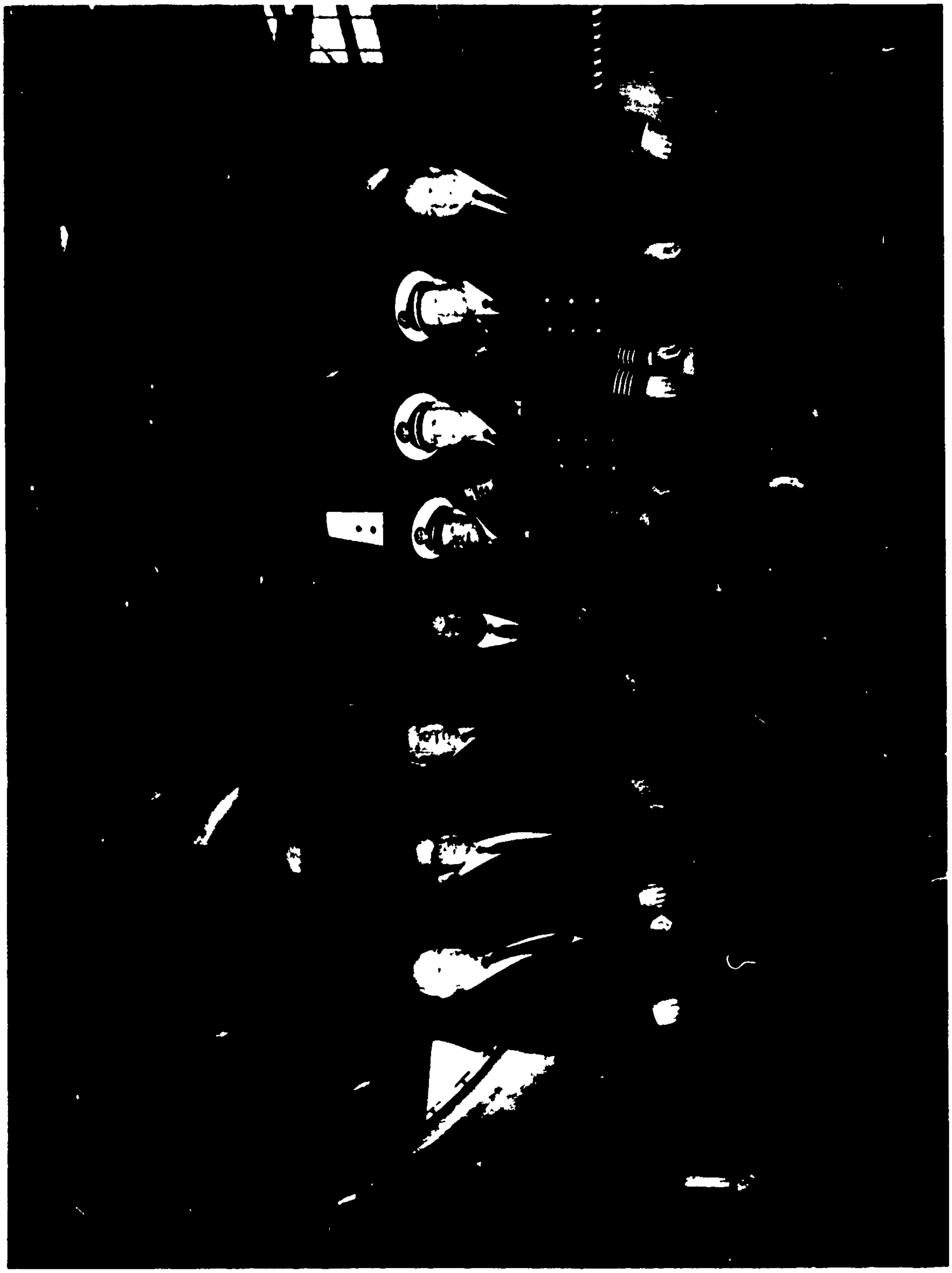

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Figure 8. Acceptance Group

G. Desmond, H. Andrews, Col. R. Hagreen, N. C. Willcox, Cdr F. Highsmith,
Capt. R. Schall, Capt. H. Benson and W. G. Gisel

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Figure 9. DCAS Group

M. Cullinan, LCDR N. Holway, E. Stocker, Col. R. Hagreen, W. Kubisty, and C. Warg

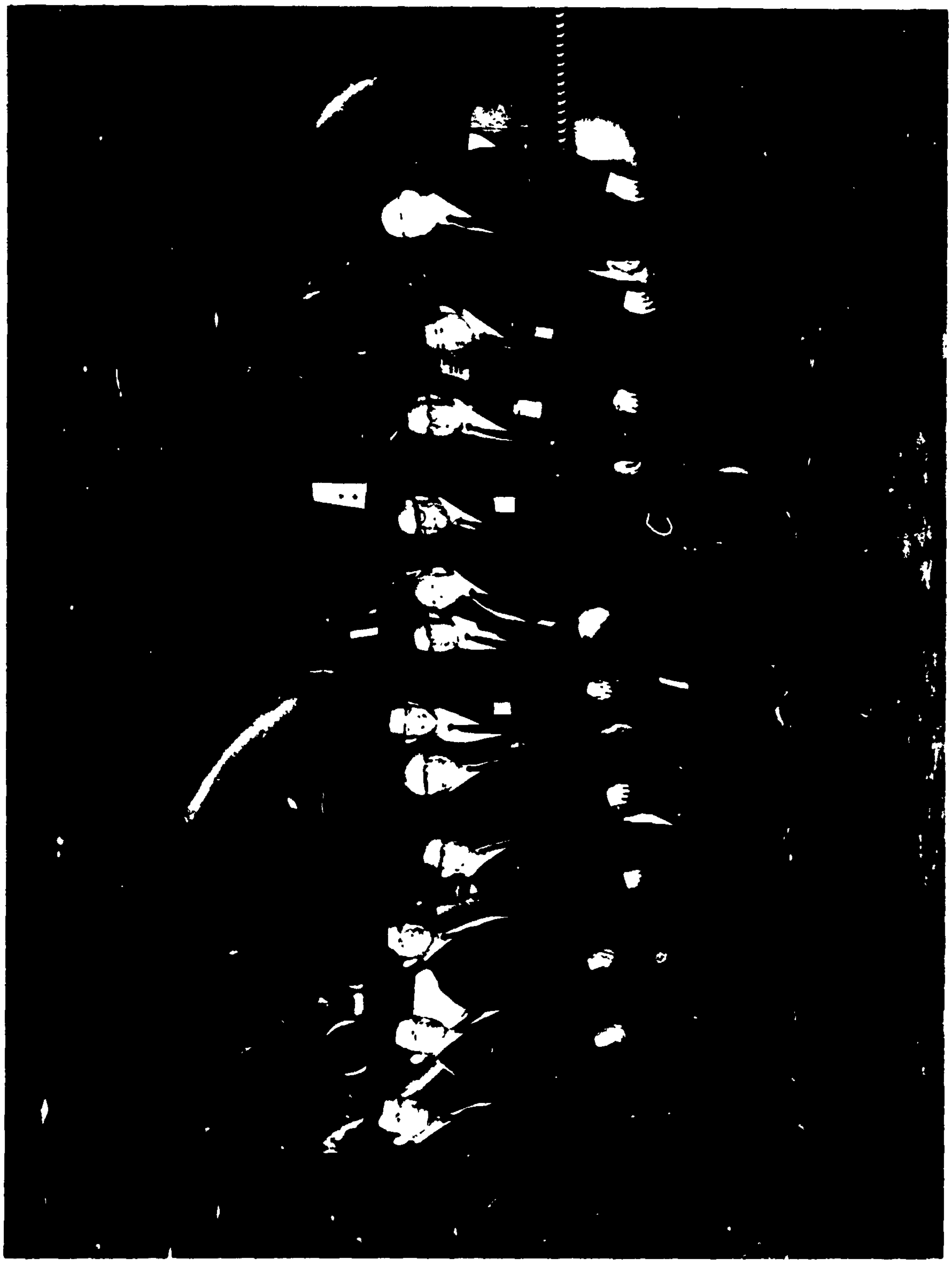

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Figure 10. Bell - NAVY Group

R. Carlin, J. Spencer, G. Flemming, J. Hart, A. Coles, M. Gampp, H. Andrews, G. Desmond, L. Wing, V. Paxhia, E. Sing, and R. Postle

IV. GENERAL

A. TRIPS AND VISITORS

1. Trips

16 April 23 May 5 June 2 July 9 July 15-16 July 6 August 20 August 26 August 8 October	NAVAIRSYSCOM	Program Discussions

2. Visitors

31 March 11 April	USN - NASC USN - NATC USN - USMC - NATC USA - AVLAB USA - ATA USA - AVSCOM USAF - AFFTC NASA - Langley	Phase II (Final) MPE and Critique
19 May	USN - NASC DCASD-DCASO	Aircraft Acceptance
12-13 August	USN - NASC	Program Review

B. OPEN ITEMS
(submitted at least 30 days prior to 31 December 1969 to NAVAIRSYSCOM or DCASO at Bell)

Bell Letter No.	Subject	Submitted	Required Approval Date
882	Bonding of Fuel, Oil and Fire Extinguishing Lines	5/14/65	*
893	Aerodynamic Stability and Control and Flying Qualities Report (2127-917003, Rev. 7)	6/4/65	
974	Aerodynamic Stability and Controls Flying Qualities Final Report (2127-917003, Rev. 8)	12/1/65	*
1054	Demonstration Planning and Progress Report (2127-931001, Rev. O)	4/26/66	*
1090	Demonstration Planning and Progress Report (2127-931001, Rev. P)	7/14/66	*
1117	Demonstration Planning and Progress Report (2127-931001, Rev. Q)	9/13/66	*
1202	Demonstration Planning and Progress Report (2127-931001, Rev. R)	5/9/67	*
1248	Flight Control System	8/1/67	*
1251	Structural Test Report - Landing Gear (2127-929010)	8/7/67	*
1256	Demonstration Instrumentation - Revision B (2127 - 931001)	8/23/67	*
1269	Demonstration Data Report - Revision A (2127 - 931002A)	9/26/67	*
1273	Demonstration Planning and Progress Report (2127-931001, Rev. S)	10/4/67	*
1284	Demonstration Planning and Progress Report (2127-931001, Rev. T)	10/23/67	*
1294	Demonstration Data Report (2127-931002B, Rev. B)	11/30/67	
1326	Report Approvals	2/21/68	*

*Bell has scheduled a 30-day interval for approval by NAVAIRSYSCOM for each of these submittals.

Bell Aerospace Company

Bell Letter No.	Subject	Submitted	Required Approval Date
1347	Internal Loads Report (2127-941009, Rev.A)	4/9/68	*
1351	Demonstration Data (2127-931002D, Rev.D)	5/1/68	*
1364	Demonstration Data Report (2127-931002 E, Rev. E)	6/20/68	
1382	Demonstration Planning and Progress Report (2127-931001 Rev. V)	5/14/68	*
1390	Load Measurements	9/19/68	*
1402	Demonstration Instrumentation Report (2127-936001) Rev. C)	10/30/68	*
1405	Final Flutter and Divergence Analysis Report	11/12/68	*
1406	Demonstration Planning and Program Report (2127-931001) Rev. W	11/12/68	*
1421	Demonstration Data Report (2127-931002) Rev. F	1/14/69	*
1450	Final Strength Summary and Operating Restrictions Report	6/5/69	*
1451	Demonstration Instrumentation Report (2127-936001) Rev. D	6/5/69	*
1458	Demonstration Planning and Progress Report (2127-931001) Rev. X	9/10/69	*
1460	Demonstration Data Report (2127-931002) Rev. G - Final	9/29/69	*
1462	Demonstration Planning and Progress Report (2127-931001X) Rev.X, amended page	10/3/69	*
1465	Demonstration Data Report (2127-931002G) Rev. G, amended pages	10/15/69	*

*Bell has scheduled a 30-day interval for approval by NAVAIRSYSCOM for each of these submittals.

END
7/28/70